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REPORT
on
GEOTECHNICAL ASSESSMENT

PROPOSED NORTHERN EXTENSION OF GERROA SAND QUARRY
GERROA AND BEACH ROADS, GERROA

Prepared for
CLEARY BROS (BOMBO) PTY LTD

Project 37673
June 2006

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1. INTRODUCTION

This report presents a geotechnical assessment of the proposed Northern Extension of the Gerroa Sand Quarry at Gerroa and Beach Roads, Gerroa. The assessment was requested by Cleary Bros (Bombo) Pty Ltd, the operators of the quarry.

It is understood that Cleary Bros (Bombo) Pty Ltd are seeking approval from the Minister for Planning to extract the sand resource, extending some 800 - 900 m northeast of the existing dredge pond area, over a period of about 15 years.

The assessment comprised a review of published and unpublished data relevant to the quarry, a visit by a senior geotechnical engineer, cone penetration testing and boring with sampling, followed by chemical and physical testing of selected samples and geotechnical analysis of resource volume and geotechnical constraints to the development. The details of the field work and subsequent analysis are given below and include reference, where appropriate, to the previous assessments and data.

As required by the Department of Environment and Conservation (NSW) in the Director General's Requirements, the assessment has included consideration of relevant geotechnical and groundwater issues included in:

- Water Quality and River Flow Interim Objective ***'Illawarra Catchment'*** (October 1999);
- Acid Sulfate Soil Manual, NSW Acid Sulfate Advisory Committee (August 1998);

- The NSW State Groundwater Policy – Framework Document, Quality Protection Policy, Groundwater Quantity Management Policy and Groundwater Dependent Ecosystems;
- State Water Management Outcomes Plan;
- State Environmental Planning Policy No. 58 – Protecting Sydney's Water Supply;
- Environmental and Health Protection Guidelines: ***Onsite Sewage Management of Single Households*** (February 1998);
- NSW EPA, Draft Environmental Guidelines for Industry: ***The Utilisation of Treated Effluent by Irrigation*** (February 1995);
- NSW Department of Housing, ***Managing Urban Stormwater: Soils and Construction*** (4th Edition, March 2004).

The preparation of the assessment has also included consideration of issues included in the Department of Primary Industries, Mineral Resources Division EIS Resource Data requirements.

The principal information sources comprised:

- ***'Sand Resources in the Wollongong Area'.*** NSW Geological Survey Report No. GS1979/071 (Unpublished);
- ***'Gerroa Sand Resource – Southern Extraction Area'.*** R W Corkery & Co. Pty Ltd Report No. 279/02;
- ***'Wollongong 1:250 000 Series Geological Series Sheet'.*** NSW Department of Mines, 1966;
- periodic rainfall, extraction face location, dredge pond level and, groundwater monitoring bore data collected by Cleary Bros (Bombo) Pty Ltd;
- materials testing carried out by Coffey Partners International Pty Ltd (Job No. SC568/1, July 1990);
- materials testing carried out by Network Geotechnics Pty Ltd (Job No. W2099/1, July 2000);
- the results of a Douglas Partners investigation (Project 25766, February 2001) of the Gerroa Sewage Treatment Works located approximately 1 km to the north of the proposed extraction area and situated within an equivalent depositional environment.

- groundwater and surface water testing during 2005 and 2006 by Earth2Water Pty Ltd (E2W) and Enviromanagers Pty Ltd, the results being included in the annual environmental management reports for 2004 and 2005.

2. SITE DESCRIPTION

The site for assessment comprises an irregularly shaped area, generally ranging from 80 – 200 m wide, extending some 800 - 900 m in a north-eastern direction from the current northern extent of the operating dredge pond (Drawing 1). The site lies at the western side of Gerroa Road and is approximately 600 m from the current beachfront.

Natural surface levels relative to Australian Height Datum (AHD) range from RL 1, adjacent to a drainage canal near the northern end of the proposed extraction area, to RL 5 – RL 7 (AHD) along the Gerroa Road frontage.

Within the current dredge pond at the southern end of the proposed extraction area, sand extraction has been carried out to depths of up to about 4 m below dredge pond water level, corresponding to about 10 m below the level of Gerroa Road.

Limited clearing of vegetation has taken place progressively in front of the current extraction face beyond which the proposed extension area is densely tree covered for a length of about 200 m, thence partially tree covered to cleared over the remaining sections (Drawing 1).

3. GEOLOGICAL AND HYDROGEOLOGICAL SETTING

Reference to the Wollongong 1:250 000 Geological Series Sheet indicates that the Gerroa Sand Quarry and proposed Northern Extension lie within the drainage basin of Crooked River which discharges to the Shoalhaven Bight approximately 3.5 km to the northeast.

The basin is bounded to the north-west (at about the alignment of the South Coast Railway some 1.5 km to the northwest) by a topographic bedrock high of Berry Siltstone of Permian age. An east-trending spur of this bedrock high also extends to near the intersection of Gerroa and Beach Roads.

The bedrock is overlain by sediments of Quaternary (Holocene) age, which may be separated into the following broad deposition modes in order of surface occurrence from the present day beach:

- beach ridges located between the current seafront and the eastern side of Gerroa Road comprising aeolian sand. The beach ridge system controls the local creek drainage which flows northeast before joining the Crooked River.
- low, aeolian sand dunes extending 100 m to 500 m from the beach ridges.
- aeolian sand sheets extending 100 m to in excess of 1 km inland from the low dunes.
- fluvial and back dune lagoonal sediments comprising inter-banded sands, clay and mud. These deposits within Foys Swamp extend westerly from the edge of the sand sheet to the South Coast Railway.

The Gerroa Sand Quarry and the proposed Northern Extension Area are located at the rear of the beach ridge system on low sand dune and sand sheet deposits.

Cleary Bros (Bombo) Pty Ltd monitoring bores in the Gerroa Sand Quarry and the area extending north-east to adjacent to the Crooked River indicate that the alluvium acts as an aquifer in which there is a moderate variation in groundwater levels but a consistent, north-east trending flow gradient (about 0.3%) adjacent to the dredge pond, possibly reflecting the topographic bedrock high adjacent to southern side of Beach Road. Elsewhere, there appears to be a generally easterly-trending flow gradient of about 0.1% - 0.2% towards the shore. There are however appear to be locally even flatter gradients and reversals of gradient, suggesting that groundwater mounding within the dunes sheds both eastward to the sea and westward to the main drainage canal which continues northward as Blue Angle Creek and thence Crooked River (both of which are tidal).

4. FIELD WORK METHODS

The project field work comprised:

- a site inspection by a senior geotechnical engineer on 18 November 2004 for site familiarisation and selection of representative test locations.
- eleven cone penetration tests (CPT 101 – 111) to depths of 15 m within and adjacent to the proposed extension area. In these tests a 35 mm diameter instrumented cone is pushed using hydraulic thrust from a 15 tonne capacity truck-mounted unit with a vertical penetration rate of 20 mm/sec. Cone tip and sleeve friction resistance are monitored and recorded on computer for later plotting.
- four sampling bores (Bores 201 – 204) at locations selected on the basis of the results of the cone penetration testing. The bores were drilled to depths ranging from 13.5 – 17.5 m using a truck-mounted Scout auger/rotary rig, the bores being initially progressed using spiral flight augers until caving conditions were encountered, then extended to final depths using rotary methods. Representative samples were collected at 1 m depth intervals using auger and standard penetration test (SPT) methods.
- the sampled materials were transported and stored in accordance with standard protocols for subsequent testing of acid sulphate soils. The logging of the sampled materials was by an experienced engineering geologist.

Previous relevant materials investigations of the immediate site area have comprised:

- two sand sampling bores (SM 5 and SM 6), drilled to depths of 9 m by the Department of Mines in 1979. Sampling and logging was carried out over 1.5 m intervals.
- three sand sampling bores (CB 201, CB 204 and CB 206), drilled to depths of depths ranging from 5.5 – 14 m by Cleary Bros (Bombo) Pty Ltd in 1990 . It is noted that the site of CB 201 has been mined and now lies within the area of the dredge pond.
- a test pit (TP 3) excavated to a depth of 7.5 m with sampling at approximately 1 – 2 m depth intervals by Cleary Bros (Bombo) Pty Ltd in 2000.

The locations of the current bores and cone penetration tests are shown on Drawing 1 and were determined using a hand held GPS unit. The collar levels were interpolated from contour data

included on an orthophotomap (an extract of which is included in Drawing 1) supplied for use in the assessment. The locations of the previous test locations are also shown on Drawing 1 and were scaled from drawings included in the previous reports for the site and as such, these locations are considered approximate only.

5. FIELD WORK RESULTS

Details of the conditions encountered in the current bores and the cone tests, together with previous subsurface investigations, are presented in Appendix A, together with notes defining classification methods and descriptive terms. Interpretative geological cross sections (Sections A – A' to G – G') summarising the results of the investigations are given in Drawings 2 and 3.

The test pit, bores and cone penetration tests intersected a regular pattern of soil and bedrock stratigraphy at the site generally consistent generally with the geological mapping.

Previous investigations summarised by R W Corkery & Co. Pty Ltd included subdivision of the sediments underlying the Gerroa Sand Quarry and part of the proposed Northern Extension Area into three units. The current detailed profiling by cone penetration testing and bores has permitted clearer definition of sediments and has permitted an extension of the previous unit descriptions as summarised below and shown on Drawings 2 and 3:

Unit 1: yellow to cream or orange brown, variably very loose to very dense, well sorted, fine to very fine grained sand and silty sand becoming fine to medium grained in places, with no shells, associated with dune deposits. The base of the unit is generally above mean sea level (about RL 0) but with isolated sections possibly extending down to RL -1. A 0.2 – 0.6 m thick organic rich silty sand topsoil was developed on the unit at Bores 201 – 204.

The unit varies in thickness from less than 1 m at the western edge of the proposed Northern Extension Area to approximately 7 m in Bore 203 adjacent to Gerroa Road.

Unit 2: fawn or orange-brown to grey, indurated in places, generally medium dense to very dense (with some loose bands), moderately well to poorly sorted, fine to very coarse grained sand with variable amounts of lithic gravel and shell, associated with a combination of beach, shore-face, barrier wash-over and tidal inlet deposits.

The base of the unit was interpreted at between RL -2 to RL -6, the unit thinning to the west and varies in thickness between about 4 m and 8 m. The unit was separated from the overlying Unit 1 by a clay lens (to about 0.3 m) in the area between CPT 104 and Bore 204.

Unit 3: dark grey to black, organic-rich, soft to stiff clay of estuarine or lagoonal deposition. The maximum thickness of the unit was approximately 2.5 m in the south-western section of the proposed Northern Extension Area. The unit thinned rapidly to less than 1 m or was absent (possibly being eroded during the marine transgression) in the north-eastern section of the area.

The base of the unit was interpreted at between RL -6 to RL -8. It is noted that a similar 0.5 – 1.5 m clay layer with a base at RL -3.5 to RL -4 was penetrated by testing at the Gerroa Sewage Works site.

The unit is interpreted as having formed in a back-dune location during a still-stand at about RL -5 preceding the stabilisation of sea level at about current levels some 6500 years before present.

Unit 4: grey to dark grey, generally medium and coarse grained, medium dense to very dense sand with included gravelly sand/sandy gravel bands, particularly at the base of the unit at the north-eastern end of the proposed Northern Extension Area.

The unit was up to 4m thick, base of the unit was interpreted at between RL -6 to RL -11. The unit generally thickened and deepened to the northeast.

Unit 5: grey, soft to very stiff and hard clay, interpreted as representing possible some alluvial material and the residual weathering profile developed on the Berry Siltstone. The maximum thickness penetrated by testing was 6 m. A similar profile was intersected at depths of 16 m to 18 m (RL –12 to RL –14) in the Gerroa Sewage Works site.

Groundwater was noted in the current bores and inferred at hole collapse depths at CPT locations at RL 0.5 – 2.5. In comparison, maximum groundwater levels of approximately RL 0.9, RL 1.4 and RL 1.6 are indicated by data obtained by Cleary Bros (Bombo) Pty Ltd in water monitoring bores WM 3, WM 4 and WM 5, respectively.

6. GROUNDWATER

The following sections assess hydrogeological factors determined from the available surface and groundwater monitoring data collected in the period 1993 – 2006. Where relevant, the available data has been compared to long-term rainfall records.

6.1 Rainfall and Pond Level

The site is located immediately adjacent to the Shoalhaven Bight and within an area characterised by a median and mean annual rainfall of about 1165 mm and 1252 mm, respectively (on the basis of over 100 years records at the Kiama and Point Perpendicular monitoring stations). Detailed (daily) rainfall records from the Gerroa Sand Quarry indicate a median and mean annual rainfall of about 1047 mm and 1065 mm, respectively, some 10% to 15% below the anticipated long-term median and average values for the local coastal area and some 6% to 9% greater than the Nowra monitoring station about 13 km inland.

Measurements of the dredge pond level have been compared to available yearly rainfall for the site in the period 1993 – January 2006 and the anticipated median rainfall value (Table 1).

Table 1 – Summary of Yearly Rainfall and Dredge Pond Levels

	1993	1994	1995	1996	1997	1998	1999	2000	2005	2006
Maximum Level (AHD)	1.9	1.88	1.875	1.825	1.85	2.175	2.175	1.65	1.65	1.1
Minimum Level (AHD)	1.4	1.27	1.0	1.35	1.35	0.95	1.15	0.95	1.15	1.05
Range of Level (m)	0.5	0.53	0.875	0.475	0.5	1.225	1.025	0.7	0.5	0.05
Total Rainfall (mm)	755	926	1134	866	1101	1440	1309	993	1147	NA
Variation from Median Rainfall (mm)	-410	-239	-31	-299	-64	+275	+144	-172	-18	NA

NA = Not available

The results shown in Table 1 indicate that:

- 1998 and 1999 had rainfall in excess of the anticipated median (1165 mm) rainfall.
- the yearly maximum dredge pond level in years of less than median rainfall moved within a limited range (RL 1.65 – 1.9) with an average maximum of RL 1.83.
- the increase in dredge pond level in 1998 and 1999 corresponded closely with the rainfall in excess of the median value.
- the yearly minimum dredge pond level also moved within a limited range (RL 0.95 – 1.4).
- the minimum dredge pond level (RL 0.95) is 0.45 m above mean sea level.
- the maximum dredge pond level (RL 2.175) occurred during the year of highest rainfall (1998) indicating the rapid effect of rainfall on the groundwater regime.

The dredge pond levels have also been compared to daily rainfall events and the results of the 1999 - 2000 record periods (when the dredge pond area was slightly smaller than the current case). The comparison indicates that:

- for daily rainfall events generally in excess of 100 mm or close spaced rainfall events totalling about 100 mm there is a similar rise in the dredge pond level.
- high dredge pond levels declined rapidly towards the minimum (base) level between August 1999 (an above average rainfall period) and June 2000 (within a below average rainfall period) with the decline being stabilised in the February to May 2000 period by some seven rainfall events in the range 10 mm to 50 mm.

When dredge pond levels are compared to the levels in the groundwater monitoring bores, there is an indication that, during years of significantly lower than median rainfall (e.g. 1993), there is a possible localised reversal of groundwater flow at the eastern end of dredge pond (see Drawing 4) compared to a normal or slightly below median rainfall period (e.g. 2000) when flow gradient continues to the northeast (see Drawing 5).

6.2 Rainfall and Evaporation from Dredge Pond

The assessed median rainfall for the Gerroa area is about 1165 mm (in comparison with 1047 mm for the period of recording at the Gerroa Sand Quarry). In comparison, available data for evaporation rates for a NSW south coast area recording station (Ulladulla) indicates that the average daily evaporation rate is of the order of 2.8 mm/day (1022 mm/year), less than either the assessed or measured rainfall data. It is however understood that readings at the Nowra monitoring station indicate average evaporation of the order of 4 mm/day (about 1460 mm/year). As such, there is an uncertainty with regard to the balance between rainfall and evaporation from the dredge pond at the site.

6.3 pH of Dredge Pond Water and Groundwater

Measurement of the pH of both the dredge pond water and groundwater in the Cleary Bros (Bombo) Pty Ltd monitoring bores has been carried out on a regular basis since 1993. The monitoring of the dredge pond and the monitoring bores WM 1 and WM 2 at the southern end of the Gerroa Sand Quarry, together with monitoring bores WM 3, WM 4, WM 5 and WM 6, the main drainage canal and Blue Angle Creek in or near the proposed Northern Extension Area indicated:

- the dredge pond pH has generally moved within the range 6.0 – 9.0 (moderately acidic to strongly alkaline) in comparison with a range of 5.4 – 8.5 (strongly acidic to strongly alkaline) for the monitoring bores.
- the lowest dredge pond pH values were measured in the period of heavy rainfall at the end of July 1998 and extreme rainfall in mid August 1998. This may reflect the flushing of organic acids or oxidised pyritic material from the sand aquifer.
- the minimum pH levels (pH 5.4 and 5.9, respectively) in the monitoring bores WM 2 and WM 3 may be an indicator of pyrite oxidation or the presence of organic acid complexes.
- the pH of Blue Angle Creek at the flood gates at the northern end of the CB property (i.e. north of the proposed quarry extension) generally ranged between 6.6 and 7.8, but with a lower pH reading of 4.8 being associated with transient stream flushing event during wet

weather. For comparison, pH readings as low as 3.2 have been recorded in the drains within Foys Swamp, upstream (west) of the proposed quarry extension area.

The conditions represented by the pH values within the dredge pond or monitoring bores described above are not considered severe. The significantly lower pH values recorded in the Foys Swamp drainage system and its discharge path (Blue Angle Creek) indicate periodic severe conditions probably related to flushing of acid formed by oxidation of acid sulphate soils.

6.4 Groundwater Quality

It is noted that the Berry Siltstone, which forms the bedrock to the immediate south of Berry Beach Road, frequently includes accessory pyrite mineralisation, but of a significantly different formation type and form than associated with acid sulphate soils. The soils developed on the Berry Siltstone are commonly acidic and surface runoff from these soils may influence the quality of the groundwater within the adjacent alluvial aquifer.

Measurement of the electrical conductivity (as an indicator of Total Dissolved Solids [TDS]) of groundwater in the dredge pond and the Cleary Bros (Bombo) Pty Ltd monitoring bores WM 1 - WM 6 has been carried out since 1993. Additional field measurement of TDS has also been undertaken by E2W and others in the dredge pond and at Blue Angle Creek. The results of the monitoring are summarised in Table 2 (see following page).

It is understood that the highest value at Blue Angle Creek was recorded at high tide and indicates substantial mixing with seawater.

Field measurements of Dissolved Oxygen (DO) have also been undertaken recently by E2W and others in the dredge pond, main canal and at Blue Angle Creek. The results indicate DO values in the ranges 65% - 100%, 24% – 100% and 26% – 92% in the dredge pond, main canal and Blue Angle Creek, respectively.

Table 2 – Summary of Electrical Conductivity (μS/cm) at Sampling Locations

Period	Electrical Conductivity (μS/cm) at sampling location							
	WM 1	WM 2	WM 3	WM 4	WM 5	WM 6	Dredge Pond	Blue Angle Creek
1993	636 - 5980	416 - 920	130 - 470	404 - 605	96 - 1140	91 - 225	400 - 626	NA
1994	390 - 2940	395 - 1162	132 - 1833	142 - 930	86 - 1140	495 - 966	NA	NA
1995	650 - 2440	322 - 1983	140 - 380	388 - 1620	96 - 490	76 - 209	NA	NA
1996	414 - 4620	321 - 1114	213 - 609	376 - 590	98 - 120	91 - 136	NA	NA
1997	2390 - 4980	335 - 501	214 - 537	351 - 677	109 - 180	73 - 120	NA	NA
1998	1220 - 6470	366 - 902	191 - 701	370 - 1052	54 - 171	93 - 236	NA	NA
1999	965 - 2900	455 - 879	161 - 314	264 - 1098	84 - 191	83 - 238	NA	NA
2000	739 - 3830	460 - 770	NA	604 - 1865	NA	113	NA	NA
September 2003-2004	278 - 1113	465 - 530	NA	NA	NA	NA	510 - 1339	750 – >20000
2005	290 - 1030	NA	NA	740 - 1110	100	NA	510 - 690	810 - >20000
Range over measurement period	278 - 6470	321 - 1983	130 - 1833	142 - 1865	54 - 1140	73 - 238	400 - 1339	750 - >20000

NA Not available

The results shown in Table 2 indicate that:

- monitoring bore WM 1, located up-gradient and closest to bedrock exposure, has the consistently highest yearly TDS values (where TDS ≈ 0.65 x μS/cm), consistent with flushing of salts from the bedrock.
- the highest minimum yearly TDS values in the monitoring bores were recorded in the up-gradient bores WM 1 and MW 2, consistent with flushing of salts from the bedrock.
- the increased minimum TDS values for the dredge pond in comparison with the surrounding groundwater mass are likely to relate to the disturbance caused by the dredging and processing procedures.
- all minimum conductivity values indicate fresh water conditions (<1500 μS/cm of the Clean Waters Regulations).

- the maximum conductivity values for the dredge pond and monitoring bores WM 5 and WM 6 indicate fresh water conditions.
- monitoring bore MW 5 has the overall highest quality water, possibly related to mounding of infiltrated rainwater within the dune sand at that location.
- the surface water quality in Blue Angle Creek fluctuates with tide, being fresh at low tide and saline at high tide.

7. LABORATORY TESTING

7.1 Physical Testing

Selected samples from the current bores were tested in the laboratory for measurement of particle size distribution (grading), particle density, water absorption and organic impurities (other than sugar). The detailed results of the current testing are given in Appendix B and additional test results of particle size distribution, shell (carbonate) content and organic impurities from the previous investigations are given in Appendix C.

The results of all testing are summarised below.

7.1.1 Grading

A total of 29 particle size distributions were determined on samples from within or adjacent to the proposed extension area. The results are summarised in Table 1 (following page) with comparison with the grading requirements and limits of deviation for uncrushed fine aggregate for use in concrete (Australian Standard AS 2758.1 – 1998).

The results indicate that the very fine and fine grained sands of Unit 1 generally do not satisfy the requirements of AS 2758.1 – 1998, the samples generally exceeding the requirement for the passing 300 μm size range. The unprocessed, medium and coarse grained sands obtained from Unit 2 and Unit 5 generally satisfy the requirements with minor exception of small excesses in the coarser and 75 μm size ranges.

It is understood that the mixing of Unit 1 and Unit 2 materials during dredging and subsequent processing have provided acceptable fine concrete aggregate during the operation of the Gerroa Sand Quarry.

Table 1 – Summary of Particle Size Distribution Testing – Proposed Northern Extension Area

Location	Depth (m)	Unit	Percentage Passing (%)							
			9.5 (mm)	4.75 (mm)	2.36 (mm)	1.18 (mm)	600 (μm)	300 (μm)	150 (μm)	75 (μm)
Bore 201	1.0	1	100	100	100	100	100	98	12	2
	2.0	1	100	100	100	100	100	92	5	1
	8.0	2	99	99	98	92	78	49	13	4
	11.0	4	100	100	100	99	89	41	8	3
Bore 202	1.5	1	100	100	100	99	98	98	9	1
	3.0	1	100	100	100	100	100	90	6	2
	5.0	2	100	100	100	99	98	78	7	2
	7.0	2	99	98	97	92	80	46	7	4
	10.0	4	98	97	96	94	73	27	10	6
Bore 203	2.0	1	100	100	100	100	100	94	11	2
	6.0	1	100	100	100	100	100	83	7	2
	9.0	2	100	98	94	85	71	39	10	3
	12.0	4	100	100	99	98	89	34	7	3
Bore 204	0.5	1	100	100	100	100	100	99	9	2
	2.0	1	100	100	100	100	100	86	5	2
	4.0	1	100	100	100	100	100	78	3	1
	7.0	2	98	97	94	90	86	47	8	3
	12.0	4	100	100	99	94	59	13	4	2
CB201	3.0 – 5.0	2	100	98	97	95	77	38	12	6
	4.9 – 5.4	2	95	94	92	88	76	43	13	5
CB204	0 – 1.0	1 - 2	100	100	100	100	98	86	17	12
	2.0 – 5.0	2	100	98	97	91	60	19	6	4
CB206	6.0 – 8.0	2	100	96	92	90	85	63	19	10
	8.0 – 10.0	4	100	97	94	88	73	44	10	6
	10.0 -13.0	4	100	100	100	99	84	41	8	3
TP3*	1.2	2	100	100	100	99	80	22	10	8
	4.0	2	100	100	100	99	89	40	13	7
	6.0	2	100	100	100	99	76	12	5	2
	7.5	2	100	100	100	100	89	33	10	5
AS 2758.1 – 1998										
LIMITS (MASS PASSING %)			100	90 – 100	60 - 100	30 – 100	15 – 100	5 – 50	0 – 20	0 – 5
MAXIMUM DEVIATION (%)			-	±5	±5	±10	±15	±10	±5	-
Note		*	Washed Samples							
			Outside Limits							

7.1.2 Particle Density, Water Absorption and Organic Impurities

Five samples were tested for particle density and water absorption. An additional three samples were tested for organic impurities (other than sugar). A further four results for organic impurities were available from the 2000 testing of samples from TP 3.

The particle density results (on dry basis) ranged from 2.33 – 2.37 t/m^3, satisfying AS 2758.1 – 1998 requirements (greater than 2.1 t/m^3) for normal weight aggregate. Water absorption results ranged from 0.3 – 1%, satisfying the AS 2758.1 – 1998 requirement (about 2%).

Organic impurities testing of current samples and samples from TP3 indicated three 'pass' and four 'fail' results, indicating a need for processing to reduce the organic content.

Shell content (by a non-standard method) was previously determined on samples selected from Bores CB 201, CB 204 and CB 206. Carbonate content by acid digestion was also carried out on washed samples from TP3. The results of these tests are given in Table 2.

Table 2 – Summary of Carbonate Content Testing

Location	Depth	Unit	Shell >1.18mm (%)	Shell <1.18mm(%)	Total Carbonate (%)
CB201	3.0 – 5.0	2	-	8.2	
	4.9 – 5.4	2	10.2	6.2	
CB204	0 – 1.0	1 - 2	-	7.5	
	2.0 – 5.0	2	1.0	2.6	
CB206	6.0 – 8.0	2	34.9	20.3	
	8.0 – 10.0	4	12.0	6.3	
	10.0 -13.0	4	1.0	1.6	
TP3	1.2	2			<0.2
	4.0	2			<0.2
	6.0	2			<0.2
	7.5	2			<0.2

7.2 Chemical Testing

As part of the current investigation, chemical testing was carried out for assessment aggressivity and of acid sulphate soil potential. The detailed results are given in Appendix D and are summarised below.

7.2.1 Aggressivity

Three samples were tested for pH, chloride and sulphate content in 1:5 soil:water extracts. The results indicated pH values in the range 6.2 – 6.7, chloride in the range 1.5 – 52 mg/kg and sulphate in the range <2.0 – 8.1 mg/kg, these being generally indicative of non-aggressive or mildly aggressive ground conditions in accordance with Australian Standard AS 2159 – 1995.

7.2.2 Acid Sulphate Testing

Sixty nine samples collected from the test bores were screened by measurement of pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). These screening tests give an approximate indication of either the presence of actual acid sulphate soils (AASS) or potential acid sulphate soils (PASS). On the basis of the screening tests, five samples were submitted to the SGS Environmental Services Laboratory for Peroxide Oxidation Combined Acidity and Sulphate (sPOCAS Method) testing.

Additional details of ASS potential are also available from the CB monitoring of Total Oxidisable Sulphur as part of the quality control of processed sand. The results of all acid sulphate soil testing are given in Table 3 (see following pages) are summarised below.

The screening and sPOCAS results indicated that:

- the pH_F levels of the samples were not indicators of AASS conditions.
- 4 samples had moderate or vigorous reaction on oxidation being positive indicators of potential acid sulphate soils (PASS) conditions.
- a total of 27 samples had significantly lower pH after oxidation, these also being positive indicators of PASS conditions. However, only one sample (Bore 201/13.0 m) gave a strongly indicative result (pH<3). The positive indicators were mostly obtained from bands within Unit 1, Unit 4 and Unit 5 materials.
- all sPOCAS samples had S_{pos} values at or in excess of the ***Action Criteria value*** (0.03%) for sandy materials as presented in ***Acid Sulphate Soils Assessment Guideline***. The S_{TPA} values showed a significant buffering effect, probably due to shell fragment content. For risk assessment, however, the higher of the sulphur and acid "trails" should be used.
- the five processed sand samples from the Gerroa Sand Quarry analysed during the period October 2003 to December 2004 had Total Oxidisable Sulphur values in the range 0.009% to 0.029%, less than or equivalent to the Action Criteria value (0.03%) when quoted to two significant places.

Table 3 – Summary of Screening and Analytical Results

Location	Depth (m)	Unit	Field Screening Tests				sPOCAS Test	
			Natural pH_F	Oxidised pH_{FOX}	pH_F - pH_{FOX}	Effervescence	S_{pos}%	S_{TPA}%
Bore 201	0.5	1	6.2	5.9	0.3	S		
	1.0	1	6.4	6.2	0.2	S		
	1.5	1	6.5	6.2	0.3	S		
	2.0	1	6.6	5.8	0.8	S		
	3.0	1	6.7	6.3	0.4	S		
	4.0	1	7.0	6.4	0.6	S		
	5.0	2	7.9	7.7	0.2	S	0.03	<0.01
	6.0	2	7.8	7.9	-0.1	S		
	7.0	2	7.9	8.2	-0.3	S		
	8.0	2	8.2	7.7	0.5	S		
	9.0	2	8.4	7.4	1.0	S		
	10.0	4	8.1	5.9	2.2	S		
	11.0	4	8.1	5.6	2.5	S		
	12.0	4	8.0	4.7	3.3	S		
	13.0	4	7.9	2.5	5.4	M	0.32	<0.01
Bore 202	0.5	1	8.3	4.8	3.5	S	0.08	<0.01
	1.0	1	8.3	5.8	2.5	S		
	1.0	1	7.9	5.6	2.3	S		
	1.5	1	8.0	5.8	2.2	S		
	2.0	1	6.8	7.0	-0.2	S		
	3.0	1	6.9	6.8	0.1	S		
	4.0	2	7.4	6.8	0.6	S		
	5.0	2	8.2	7.4	0.8	S		
	6.0	2	7.9	7.4	0.5	S		
	7.0	2	7.7	7.6	0.1	S		
	9.0	2	7.7	7.7	0.0	S		
	10.0	4	7.7	5.6	2.1	S		
	11.0	4	7.7	4.8	2.9	S - M		
	12.0	4	7.7	5.9	1.8	S		
	13.0	4	6.6	6.2	0.4	S		
	14.0	4	6.8	6.2	0.6	S		
	15.0	4	7.0	6.2	0.8	S		
Bore 203	0.5	1	7.5	6.0	0.5	S		
	1.0	1	7.2	6.1	1.1	S		
	1.5	1	7.3	6.0	1.3	S		
	2.0	1	7.3	6.4	0.9	S		
	3.0	1	7.7	6.5	1.2	S		
	4.0	1	7.4	6.5	0.9	S		
	5.0	1	7.4	6.5	0.9	S	0.09	<0.01
	6.0	1	7.4	6.8	0.6	S		
	7.0	1	7.9	7.4	0.5	S		
	8.0	2	7.7	7.5	0.2	S		
	9.0	2	7.5	6.8	0.7	S		
	10.0	2	7.4	7.1	0.3	S		
	11.0	2	7.6	7.5	0.1	S		
	12.0	4	7.9	7.2	0.7	S		
	13.0	4	7.9	7.2	0.7	S		
	14.0	4	7.9	7.0	0.9	S		
	15.0	4	7.9	6.9	1.0	S		

Table 3 – Summary of Screening and Analytical Results (Continued)

Location	Depth (m)	Unit	Field Screening Tests				sPOCAS Test	
			Natural pH_F	Oxidised pH_{FOX}	pH_F - pH_{FOX}	Effervescence	S_{pos}%	S_{TPA}%
Bore 204	1	0.5	7.3	6.2	1.1	S		
	1	1.0	7.4	6.2	1.2	S		
	1	1.5	7.4	6.5	0.9	S		
	1	2.0	7.4	6.2	1.2	S		
	1	2.5	7.4	6.1	1.3	S		
	1	3.0	7.3	6.1	1.2	S		
	1	4.0	7.2	6.1	1.1	S		
	1	5.0	7.9	7.9	0.0	S		
	2	6.0	7.9	7.1	0.8	S		
	2	7.0	8.2	7.3	0.9	S		
	2	8.0	8.2	7.7	0.5	S		
	2	10.0	6.3	6.4	-0.1	S		
	4	11.0	6.2	6.4	-0.2	S		
	4	12.0	6.5	6.4	0.1	S		
	4	13.0	6.6	6.5	0.1	S		
	4	14.0	7.7	6.5	1.2	M	0.89	0.47
	5	15.0	7.8	6.5	1.3	V		
Processed Sand Stockpiles								
GS1 (13/10.03)							0.029	
GS2 (13/10/03)							0.025	
GS1 (17/08/04)							0.022	
GS2 (17/08/04)							0.028	
GS (13/12/04)							0.009	

Note: Bold indicates positive indicator S = Slight M = Moderate V = Vigorous

8. COMMENTS

8.1 Proposed Development

Cleary Bros (Bombo) Pty Ltd are seeking approval from the Minister for Planning to extract the sand resource from the Northern Extension Area, which extends some 800 - 900 m northeast of the existing dredge pond area, over a period of about 15 years. The approximate outline of the area is given on Drawing 1.

It is expected that an excavation face ranging from 80 m to 160 m wide will be progressively moved northward from the current dredge pond and that excavation depths of up to 17 m will potentially be developed to recover materials from Units 1, 2 and 4 within the area shown on Drawings 1 and 2. The closest approach of the extraction area to the main canal will be 40 m and there will be a buffer, some 25 m wide, will be provided for screening bunds between the extraction area and road reserve (Gerroa Road). It is understood that the existing processing area at the western edge of the current dredge pond will also be used for the proposed extraction operations.

8.2 Geological Model of Resource

The geological model for Northern Extension Area resource, as summarised in Drawings 2 and 3, comprises an upper, very fine to fine grained dune sand (Unit 1) underlain by generally medium to coarse grained sands of beach and tidal inlet deposits (Units 2 and 4). Clayey materials (Unit 3 and possibly the upper section of Unit 5) of lagoonal or back swamp depositional mode, which are likely to include sulphidic materials, form semi-continuous lenses to 3 m thick within the south-western section of the area, but are discontinuous and generally less than 1 m thick in the remaining sections. The area is characterised by a groundwater table that ranges between a base level of RL 0.95 and RL 2.2 in response to rainfall.

The resource is partially affected by the presence of potential acid soils, mostly within the deeper sections of Unit 4 which may include pyritic materials eroded from the underlying Unit 5 during the marine transgression leading to the current sea level. The positive indicators PASS within Unit 1 are considered to be anomalous to the aeolian deposition mode and may result from clayey particles blown from the Foys Swamp area, which is recorded on acid sulphate risk maps as being of high probability of acid sulphate soil conditions.

Materials from Units 1, 2 and 4 form the recoverable resource. The processing of the very fine to fine grained sands of Unit 1 with the underlying Units 2 and 4 sands, which extend to depths of 17 m, is expected (on the basis of the satisfactory performance of the Gerroa Sand Quarry) to produce fine concrete aggregate and reduce pyritic materials to acceptable levels by appropriate processing.

8.3 Acid Sulphate Soil Risk

The previous sand extraction within Units 1 and 2 has been satisfactorily managed the risk of acid generation and heavy metal release associated with the acid sulphate soils and the continued extraction of these units should also be expected to result in a satisfactory outcome. However, as a consequence of the exceedance of the ***Action Criteria*** in some Unit 1 materials (although considered to be anomalous results) and in some Unit 2 and Unit 4 samples, together with the significant volume of the proposed excavation, a detailed Acid Sulphate Soil Management Plan (ASSMP) is required. Planning and management options should therefore assume that, unless otherwise indicated by site-specific testing before or during excavation, all materials of estuarine origin (Units 2, 3 and 4) and the site in general need to be tested and/or monitored. The excavated Unit 4 materials of acid sulphate soil risk may require specific processing such as sluicing or hydrocycloning, the extent of which will need to be determined during the on-going extraction operation.

It is considered that an appropriate ASSMP should include:

- continuation of the current surface, groundwater and dredge pond water quality monitoring prior to, during and subsequent to the extraction process.
- installation of additional monitoring bores in the buffers between of the proposed extension area and the main canal and Gerroa Road, together with an additional monitoring bore to the north of the proposed extension area.
- additional testing of the acid sulphate soil potential to supplement the results of this investigation. This testing should be progressively carried out to permit selection of the final extraction areas and relevant treatment methods for the individual sections and/or units to be extracted within the resource.
- on-going monitoring of the feed stock and processed materials including reject slimes during the extraction.
- controlled placement of reject materials, including sulphidic fines and the oversize shell component from the processing (to assist in pH buffering) within the basal section of the dredge pond. The burial of these materials with non-sulphidic material may be appropriate.

- the holding on site of suitable quantities of buffering materials for addition to the dredge pond if modification of the pH is required on the basis of the on-going testing.

8.4 Plant Operation and Excavation Stability

The sand resource includes two distinct excavation environments; up to 4 m of very loose to very dense, very fine grained and fine grained sand and silty sand (Unit 1) lying above the water table and up to 13 m of fine grained sand (remainder of Unit 1) and medium dense to very dense, medium to coarse grained sand (Units 2 and 4). In general, an average lower-bound friction angle of about 30° is considered appropriate to the intersected sand profile.

The excavation of the profile above the water table would probably be stripped of topsoil and root affected sand (totalling an average of about 0.5 m in the current bores) by dozer operation, with the subsequent winning of materials by an excavator loading into trucks. Once the groundwater level is approached, it is anticipated that access difficulties would result in the use of the dredge system currently in use within the Gerroa Sand Quarry. Where the removal of the clays of Unit 3 to provide access to the underlying sand (Unit 4) is economic, it is probable that the soft to stiff clay would require the use of a cutter-suction type dredge, possibly with the assistance of a long-reach excavator mounted on a barge or working from the head of the excavation.

Observation of the working method within the Gerroa Sand Quarry and review of survey sections through the dredge pond area indicates that:

- water removed from the pond during dredging is returned almost directly to the pond via run-off from the discharge/processing area or via rapid infiltration of the sand profile about the working area.
- the working method does not lead to the extraction and disposal of the groundwater from the site. Rather, the pond water is recycled rapidly during the sand extraction process with possible minor additional evaporation. The records of the dredge pond pH indicates that while pyritic material is present within the sand resource, the exposure time during extraction, processing and stockpiling, is insufficient to cause complete oxidation and increase in the water acidity in comparison with the pH of the groundwater sampled from the

nearby monitoring bores. Alternatively, as suggested by the current testing, relatively benign pH could signify generally low pyrite contents and a buffering of the system by included shells.

The proposed extraction of the sand resource will need to considered the long-term stability of the dredge pond, such that there is no migration of the batters of the completed pond outside of the nominated resource and to this end, it is suggested that an average excavation slope of not greater than 25° (about 2.1H:1V) be employed.

It is anticipated that the stripped organics affected topsoil or silty sand and reject (slimes and larger shell fragments) materials will be placed into the completed dredged area. Suggested design criteria for the restored dredge pond (considered to be equivalent of a sheltered basin structure) are:

- a 6H:1V batter for required beach zones in accordance with current development conditions.
- a 2H:1V to 3H:1V maximum batter where re-vegetation and maintenance is required above the beach zone.
- an underwater maximum batter of 4H:1V at depths greater than 1 m below extreme low water level.

If sulphidic slimes won from processing are to be deposited in the base of the completed dredge pond, consideration will need to be given to any requirement for capping of these materials to promote or maintain an anaerobic deposition environment.

8.5 Groundwater Issues

The current EPA Licence and Development Consent require:

- a monitoring of discharged water at the overflow pipe from the dredge pond.
- monitoring of groundwater levels and water quality in the monitoring bores in and around the quarry and in the dredge pond, monthly and following any periods of extreme wet weather.

- water quality testing including, as a minimum, conductivity (a measure of total dissolved solids) plus pH and in the event that acid sulphate material is detected the possible requirement for monitoring of additional water quality parameters.
- flood bunding to RL 3.2.

Crooked River system, including Blue Angle Creek, is an uncontrolled lowland river for which relevant River Flow Objectives (RFO) and Water Quality Objectives (WQO) are:

- total phosphorus <25 μg/L
- total nitrogen <350 μg/L
- turbidity 6 – 50 NTU
- salinity 125 - 2200 μS/cm
- dissolved oxygen 85 – 110% saturation
- pH 6.5 – 8.5.

Applicable target water criteria (after ANZECC 2000 or NSW Clean Waters Regulations 1972 where no ANZECC Guidelines are available) are for surface discharge or for potential subsurface migration of water from the existing or proposed dredge pond to the groundwater or the adjacent "fresh" water drainage canal system.

- pH between 6.5 and 9.0
- Dissolved oxygen (DO) > 6 mg/L (>80 – 90% saturation)
- Total dissolved solids (TDS) <1500 mg/L
- Total suspended solids (TSS) <50 mg/L
- Fe (total) <0.5 mg/L and Al (total) <0.055 mg/L for pH >6.5.

The available chemical test results for surface and groundwater (see Appendix E) for the period 2004 and 2005 indicates that the water within the current dredge pond satisfied all ANZECC criteria with the exception of the Fe (total) value (which is expected to be naturally elevated in the geological environment including acid sulphate materials and weathering of pyritic iron which forms an accessory mineral of the underlying bedrock of the Berry Formation). The

dredge pond water is generally of higher quality than the up-gradient groundwater and surface water in adjacent waterways that pass through the back dune AASS and PASS deposits of Foys Swamp and discharge to Blue Angle Creek. During the period, the dredge pond water also met the WQO criteria for total phosphorus.

The monitoring results of the dredge pond since 1993 indicate that the pH of stored water was less than the NSW Clean Waters Regulation value of 6.5 only during the wettest year (1998). The lowest value (pH 6.0), which is within the ANZECC 2000 range for surface water, is assessed as resulting from flushing of acids generated by the oxidation of ASS. All electrical conductivity values for the dredge pond are within the ANZECC 2000 and WQO guidelines ranges.

The available chemical test results indicates that the extraction and processing of the sand from the proposed Northern Extension Area should not result in the pH and TDS guideline values given above being exceeded. As discharge of surface water (of higher quality than the receiving stream) from the bunded, inwardly drained site is not expected (no use of the discharge channel to date) and the groundwater gradient between the proposed dredge pond and the main drainage canal will be slight, there is minimal risk of the proposed development adversely affecting the quality of water in Blue Angle Creek.

The minimum groundwater level (RL 0.95) observed in the dredge pond to date represents a base level related to the tidal water levels in the adjacent tidal section of Blue Angle Creek and the main drainage canal. Consequently, the extraction of the sand from the Northern Extension Area should not result in drawdown of the groundwater table below the previously observed minimum level.

8.6 Resource Estimate

The following estimates (Table 4) of sand resource within the limits of the proposed Northern Extension Area as shown on Drawing 1 have been determined on the basis of:

- the stratigraphic profile interpreted from the current and past investigation data (Drawings 2 and 3).

- cross-sectional areas through the various units taken at 100 m intervals along the length of the proposed extraction area with the volumes being determined by average end-area methods.
- an excavation batter of 2.1H:1V both above and below the dredge pond level.
- a stripping depth of 0.5 m.
- limiting the suction dredging of the resource to above Unit 3 where this is present and greater than 1 m thick (about mid-distance between Sections F – F' and G – G' (Drawing 3).
- alternatively, removing the clay Unit 3 layer to a maximum of 2 m thickness.
- the assumption that all acid sulphate materials can be successfully processed for the intended final use and that environmental constraints can be managed.

Table 4 – Summary of Resource Estimate

Excavation Alternative	Volume of Sand Insitu (m^3)	Volume of Unit 3 Removed (m^3)
Unit 3 Excavated <1 m thick	661 400	3 500
Unit 3 Excavated <2 m thick	677 500	25 700

9. SUMMARY

From consideration of the available data, site records and inspection and investigation, it is our opinion that:

- the proposed Northern Extension Area includes an estimated 661 400m^3 of sand expected to be recoverable using a combination of the suction dredge (as current) and long-reach excavator operations in areas where included clay bands/lenses (Unit 3) are less than 1 m thick.
- the recovery of an additional 16 100 m^3 of sand from the lowest sand unit (Unit 4) within the southern third of the area would require the removal of an additional (approximately) 22 200 m^3 of clay (Unit 3) where the unit is between 1 m and 2 m thick.

- the proposed extraction within the Northern Extension Area sand resource will not result in variation in the range of groundwater levels or pH that have been previously experienced in the current dredge pond or adjacent water monitoring bores.
- appropriate engineering design can provide long-term stability of the dredge pond adjacent to adjacent forested areas and the easement of Gerroa Road.
- the final water body will not affect the overall commercial use of the aquifer. Average direct rainfall to the pond may be excess of the estimated yearly evaporation from the pond surface, the pH range (moderately acidic to strongly alkaline) is within the natural range of the groundwater and the down gradient landuse is restricted to National Park activities.
- surface water release or groundwater movement from the proposed dredge pond is not expected to result in deterioration (or improvement) of the quality of the water in Blue Angle Creek. The installation and sampling of new monitoring bores, together with the continued sampling and testing of existing groundwater and surface water sampling sites, will provide on-going auditing of any effects of the extraction process.
- potential acid sulphate soil conditions exist within the sand resource and are locally exceed the action criteria. Similar conditions probably also in the included Unit 3 clays and some sections of the Unit 5 clays forming the base level of the deposit.
- as a consequence of the exceedances of the action criteria, an acid sulphate soil management plan will be required. However, the available data on groundwater indicators are not strongly indicative of actual sulphate soil conditions nor does the dredge pond monitoring indicate that the extraction process within Units 1 and 2 is resulting in oxidation of significant amounts of pyritic material.

DOUGLAS PARTNERS PTY LTD

Reviewed by

G R Wilson
Principal

Dr T J Wiesner
Principal

APPENDIX A
Notes Relating to this Report
Results of Field Work

Douglas Partners
Geotechnics · Environment · Groundwater

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow

sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7

  as 4, 6, 7
  N = 13

- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm

  as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

q_c (MPa) = (0.4 to 0.6) N (blows per 300 mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on

soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers,

Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Cone Penetrometer Test

The Dutch cone penetrometer test (CPT) is increasing in importance as a means of supplementing or replacing conventional borehole drilling and sampling. These notes describe current techniques and equipment, and illustrate some of the methods of interpretation of test results.

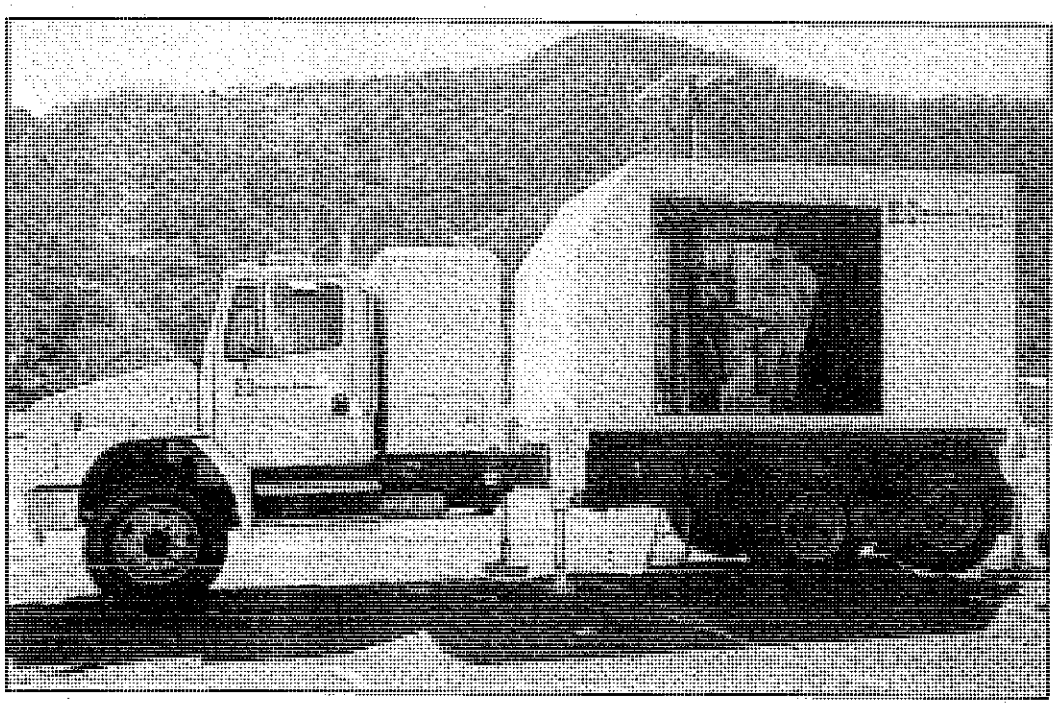
GENERAL PRINCIPLES

The cone penetrometer test, developed initially in Holland, is now standardised throughout the world as a method of site investigation, predominantly used in alluvial soils.

The test utilises a 35mm dia. cone with a following friction sleeve which is pushed into the soil by hydraulic thrust. Push rods, of the same diameter, are added at 1m intervals and penetration to depths of 30 - 50m can be achieved if conditions are suitable.

Measurements are made of the resistance to penetration of both the cone and the friction sleeve and are expressed in terms of end bearing pressure on the cone and average shaft friction on the sleeve (in MPa and kPa, respectively). The ratio between the frictional resistance and the cone resistance (friction ratio) is generally low in sands and high in clays, thus providing an interpretive method of determining soil stratification. The cone resistance value provides a continuous measure of soil strength or density.

The test procedure is covered by Australian Standard AS 1289 ("Testing Soils for Engineering Purposes") — Section F5.



METHOD OF OPERATION

Up until the early 80's, "mechanical" equipment was used, with central push rods to actuate the cone, with forces and measured by pressure gauges in surface mounted hydraulic cylinders.

Today's equipment utilises electronic methods with:

- strain gauges in the cone and friction sleeve, connected by wiring through the push rods to the surface
- a site monitor and computer to capture the data — results are displayed on a screen
- replay of results on an office plotter
- an inclinometer in the cone to measure deviations from vertical.

Testing is preferably carried out from a purpose designed ballasted truck-mounted unit, with sufficient thrust capacity to ensure penetration of dense layers. A unit with about 15 tonnes thrust is normally adequate for most situations.

Testing may also be carried out from the feed system of drill rigs, but unless special anchoring is undertaken, the available thrust capacity of 2 – 3 tonnes is not sufficient to penetrate dense sand layers or extensive zones of stiff clays.

The 35mm cone and friction sleeve are attached to push rods of the same diameter and pushed into the soil by a hydraulic ram. New rods, through which the electrical data cable has been pre-threaded, are added after each 1m of penetration. The rate of penetration is set at 20mm/second and strain gauge signals are sampled by the surface monitor at 20mm intervals. Digital results for cone resistance, shaft adhesion and friction ratio are displayed on the screen of the on-site computer and on completion of each test, the operator can view a graph of the results. These are stored on a floppy disk for later office replay on a plotter.

ADVANTAGES AND APPLICATIONS

Advantages of the cone penetrometer test in engineering site investigations are:

- reliable information, not subject to operator techniques and with minimal need for on-site supervision
- continuous (rather than intermittent) measure of density or strength
- extensive data available from previous experience for analysis and interpretation of results
- immediate charting of results
- high output — 80 to 120m per day
- low cost technique, less than alternative borehole drilling, sampling and in-situ testing
- accurate measurement of stratification depths and recording of thin layers, often missed in borehole investigations.

The test system is most suited for alluvial soils and depths of up to 30 – 50m are possible, depending on ground conditions.

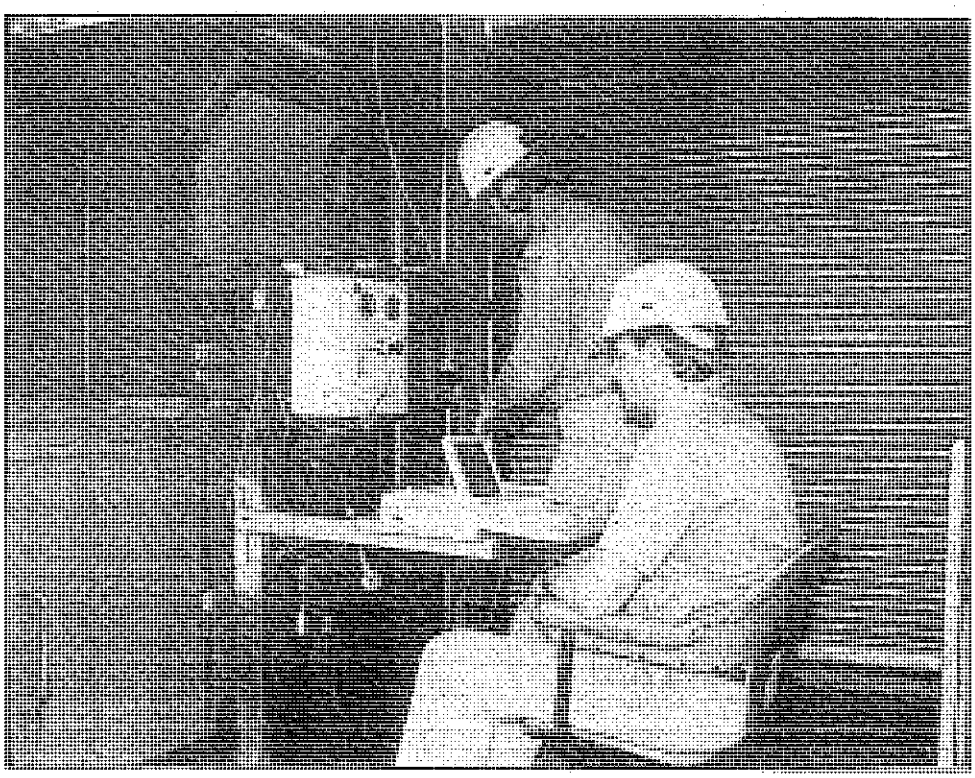
The test is not suitable in very gravelly soils or residual soils which may contain fragments or weak rock zones which impede or deflect the cone.

On sites containing rubble or rock filling, initial assistance may be required from a drilling rig to penetrate the surface.

The information obtained from the test can be used for design of shallow foundations, pile systems and retaining structures and the estimation of settlements of compressible soils.

CONDUCTIVITY MEASUREMENTS FOR GROUNDWATER

Cone technology can be used also in groundwater investigations. The conductivity cone can measure variations in soil conductivity with depth, making it an ideal tool in the investigation of saline groundwater or pollutant plumes.



COMPANY FACILITIES

Company inhouse facilities for cone penetrometer testing include:

- cones and monitor units with automatic capture of results
- incorporation of an inclinometer in the cones to ensure verticality
- truck-mounted, ballasted, custom-designed deployment units attached to Sydney and Brisbane offices
- trailer mounted rig and light hand operated equipment for confined areas
- heavy-duty drilling rig with a separate jacking frame in the centre of the unit to allow high capacity testing
- conductivity cone for groundwater investigations.

These facilities are continually being upgraded to keep abreast of technology improvements.

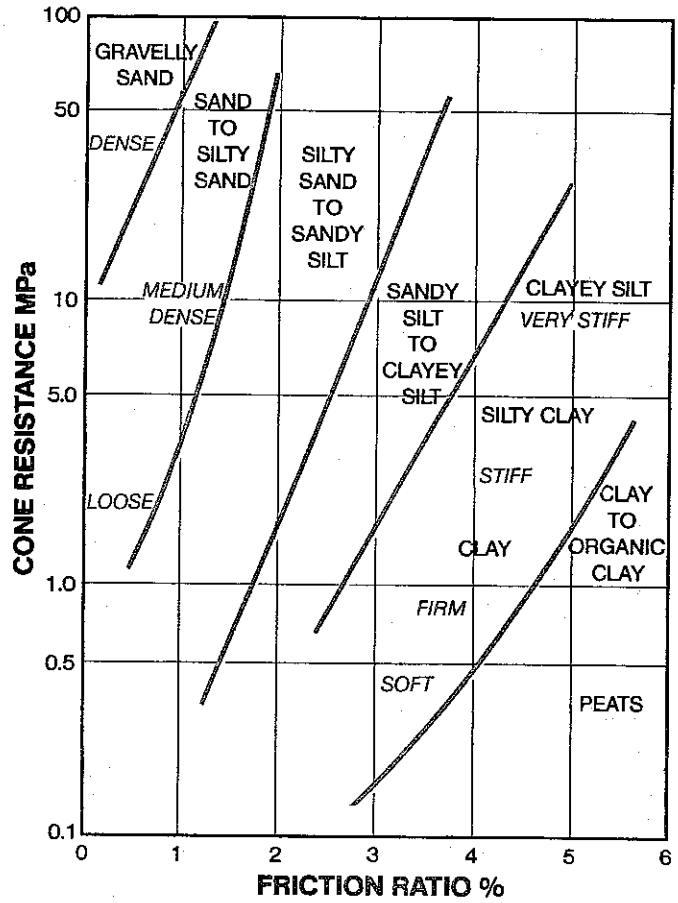
INTERPRETATION OF RESULTS

A great deal of research and investigation has been carried out to correlate the results of CPT's with other physical soil properties.

DETERMINATION OF SOIL TYPE

The ratio of sleeve friction to cone resistance (friction ratio — expressed as %) is used as an indication of the soil type being probed. In sands, friction ratios are generally low and of the order of 1 – 2%. In clays (with much higher shaft friction), the ratio may range up to 6 – 8%.

A chart which allows assessment of soil type is given below:



With the above, the cone-friction sleeve results allow an accurate assessment of layer thickness (stratigraphy) within a profile. The test method will provide a very much more accurate delineation of layers than is possible with conventional drilling and sampling, where information is only obtained intermittently. The cone test will frequently pick up thin layers which may be unnoticed in a conventional borehole investigation.

DETERMINATION OF SOIL STRENGTH

Soil strength is usually determined from the cone resistance values. The normally accepted relationship for clays, linking undrained shear strength with cone resistance is:

$c_u = (q_c - \sigma)/k$

where q_c = cone resistance
c_u = undrained cohesion
σ = effective stress
k = 12 – 15

For sands, there are a number of methods of linking cone resistance values with friction angle (ϕ). Interpretation must normally take into account the overburden pressure, but as a guide, for a depth of around 5m, the following is an approximate correlation:

q_c (MPa)	1	4	12	30
ϕ (degrees)	28	32	36	40

CORRELATION WITH SPT VALUES

There have been many measurements to correlate standard penetration test values with CPT's. For medium to coarse sands, the correlation is:

q_c (MPa) = (0.4 to 0.6)N (blows per 300mm)

For fine sands, the multiplier is 0.3 to 0.45.

MODULUS AND DEFORMATION VALUES

Published correlations linking cone resistance and modulus or compressibility values indicate a relatively wide range of values. This is probably due to inherent soil variability, time effects and the fact that modulus in any case is not uniquely dependent on strength or density.

For clays, the published correlations are mainly in the range $E = (3 \text{ to } 7)q_c$ (E = Young's modulus). Values of the multiplier of around 3 – 5 are probably most appropriate for soft, normally consolidated clays, with values of 5 – 7 for stiffer and slightly over-consolidated clays. Values in excess of 10 may be appropriate for heavily over-consolidated or residual clays.

For sands, published correlations are mainly in the range $E = (1.5 \text{ to } 5)q_c$, with values towards the upper end of the range being appropriate in most circumstances.

FOUNDATION DESIGN

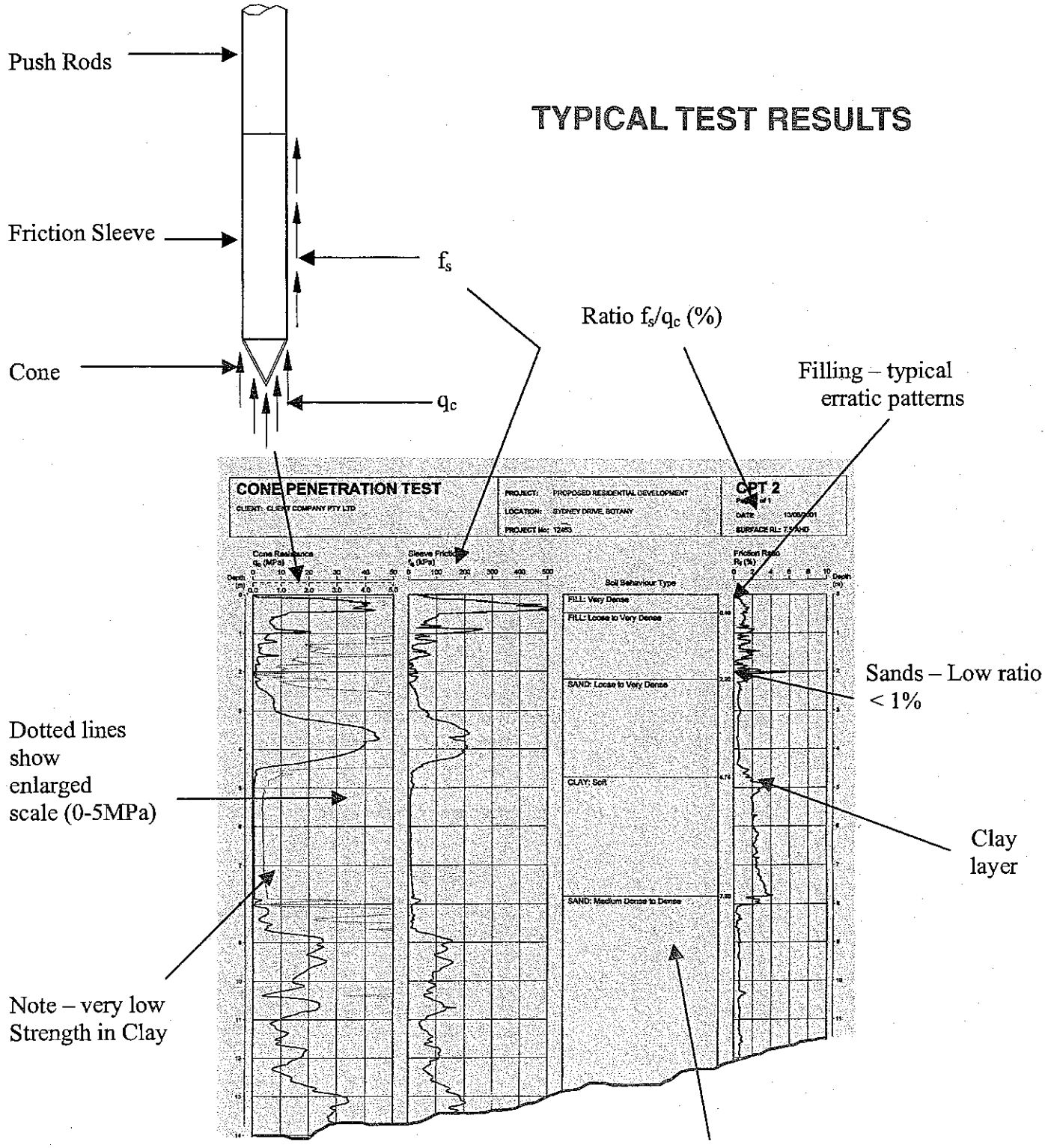
A number of methods are available which utilise cone results directly for the design of both shallow and deep foundations.

The cone is often considered as a model "pile" and for pile design, corrections are needed for the scale effect and the fact that static rather than "quasi static" bearing capacity is measured. More detailed information is given in the references.

REFERENCES

1. Standards Association of Australia, "Methods of Testing Soil for Engineering Purposes" AS 1289 F.15. — 1977 — Determination of the Static Cone Penetration Resistance of a Soil — Field Test Using a Cone or a Friction Cone Penetrometer.
2. SANGLERAT, G. "The Penetrometer and Soil Exploration", Developments in Geotechnical Engineering, 1, Elsevier 1972.
3. MEYERHOF, G.G. General Report — "Outside Europe" Proceedings of the European Sym. on Penetration Testing, ESOPT, Stockholm, June 5 – 7 1974 Vol. 2:1.
4. VARIOUS — "Design Parameters in Geotechnical Engineering" VII European Conference on Soil Mechanics and Foundation Engineering Brighton 1979 Vol. 1–4.
5. MITCHELL, J.K., LUNNE, T.A., "Cone Resistance as Measure of Sand Strength", ASCE Jnl. of Geotech. Engineering Division, July 1978.
6. SCHMERTMANN, J.H. "Static Cone to Compute Static Settlement on Sand" Proc. ASCE Jnl. Soil Mech. and Found. Div. 1970.
7. ISOPT 1, "Proceedings of First International Conference on Penetration Testing", Florida 1988, Balkema.

TYPICAL TEST RESULTS



CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

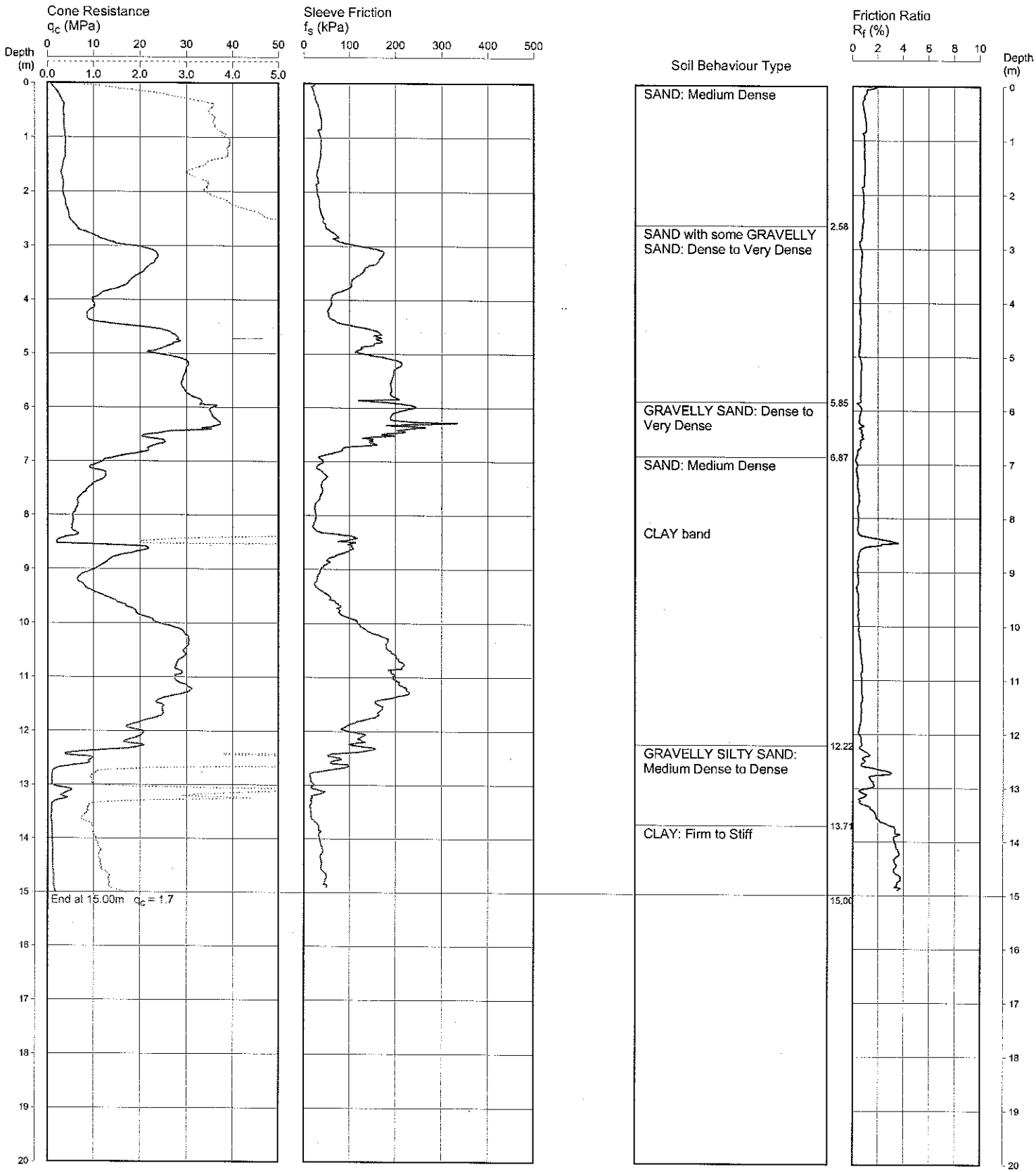
LOCATION: GERROA & BEACH ROADS, GERROA

PROJECT No: 37673

CPT 101

DATE 9/12/04

SURFACE RL: 4.9



REMARKS: HOLE COLLAPSE AT 3.35m
E 280492 N 1150028 (ISG) : E 297594 N 6149316 (MGA)

Date Plotted 3/01
Checked

File: N:\GEOTECHNICAL PROJECTS\376\37673\CPT files\37673101.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

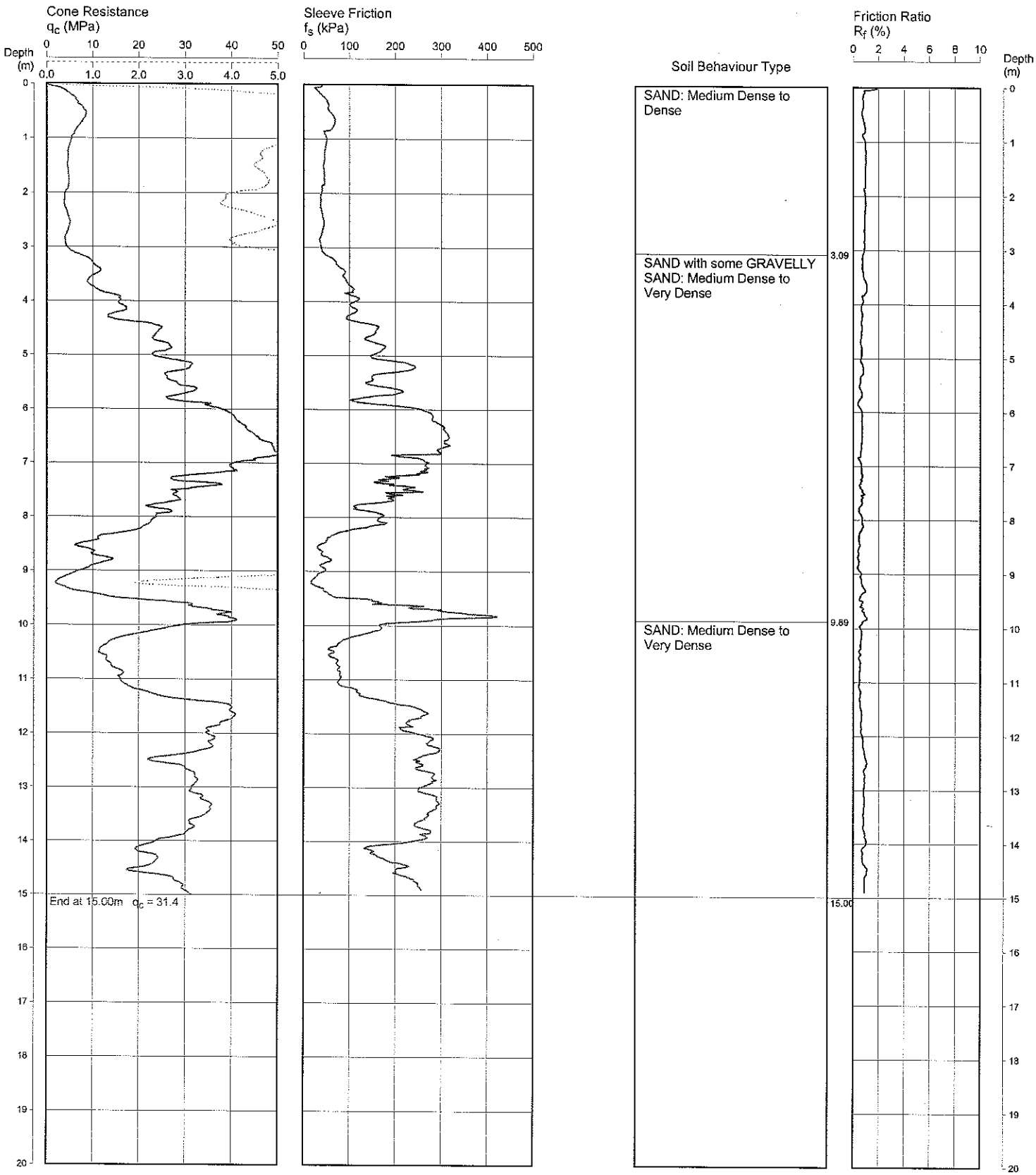
PROJECT No: 37673

CPT 102

Page 1 of 1

DATE 9/12/04

SURFACE RL: 5.2



REMARKS: HOLE COLLAPSE AT 4.2m
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Date Plotted 3/01
Checked

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Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

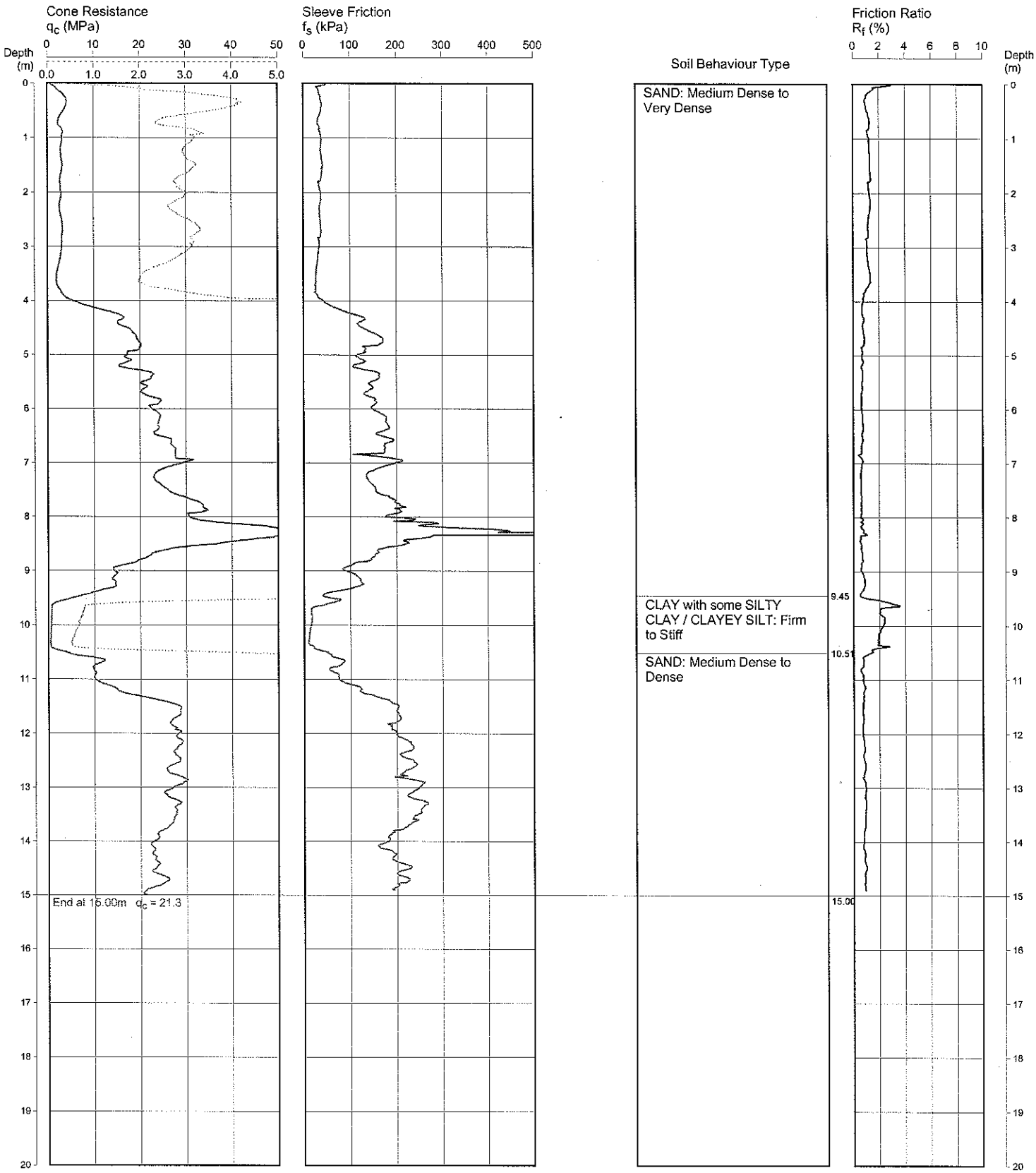
PROJECT No: 37673

CPT 103

Page 1 of 1

DATE 9/12/04

SURFACE RL: 5.3



REMARKS: HOLE COLLAPSE AT 4.65m
E 280331 N 1149932 (ISG) : E 297435 N 6149217 (MGA)

Date Plotted 3/05/2005
Checked

File: N:\GEOTECHNICAL PROJECTS\376\37673\CPT files\37673103.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

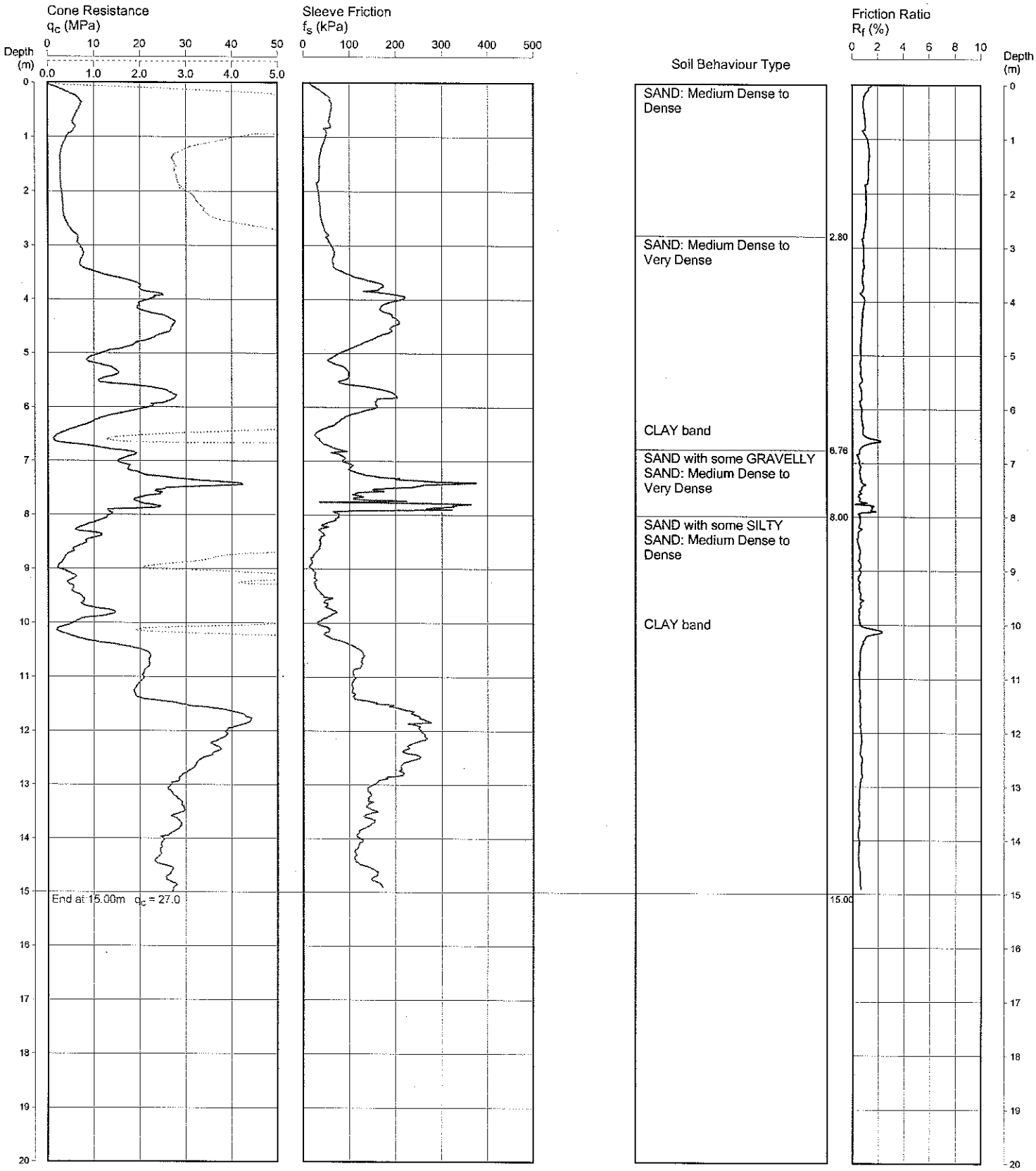
PROJECT No: 37673

CPT 104

Page 1 of 1

DATE 9/12/04

SURFACE RL: 5.8



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Date Plotted 3/05
Checked

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Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

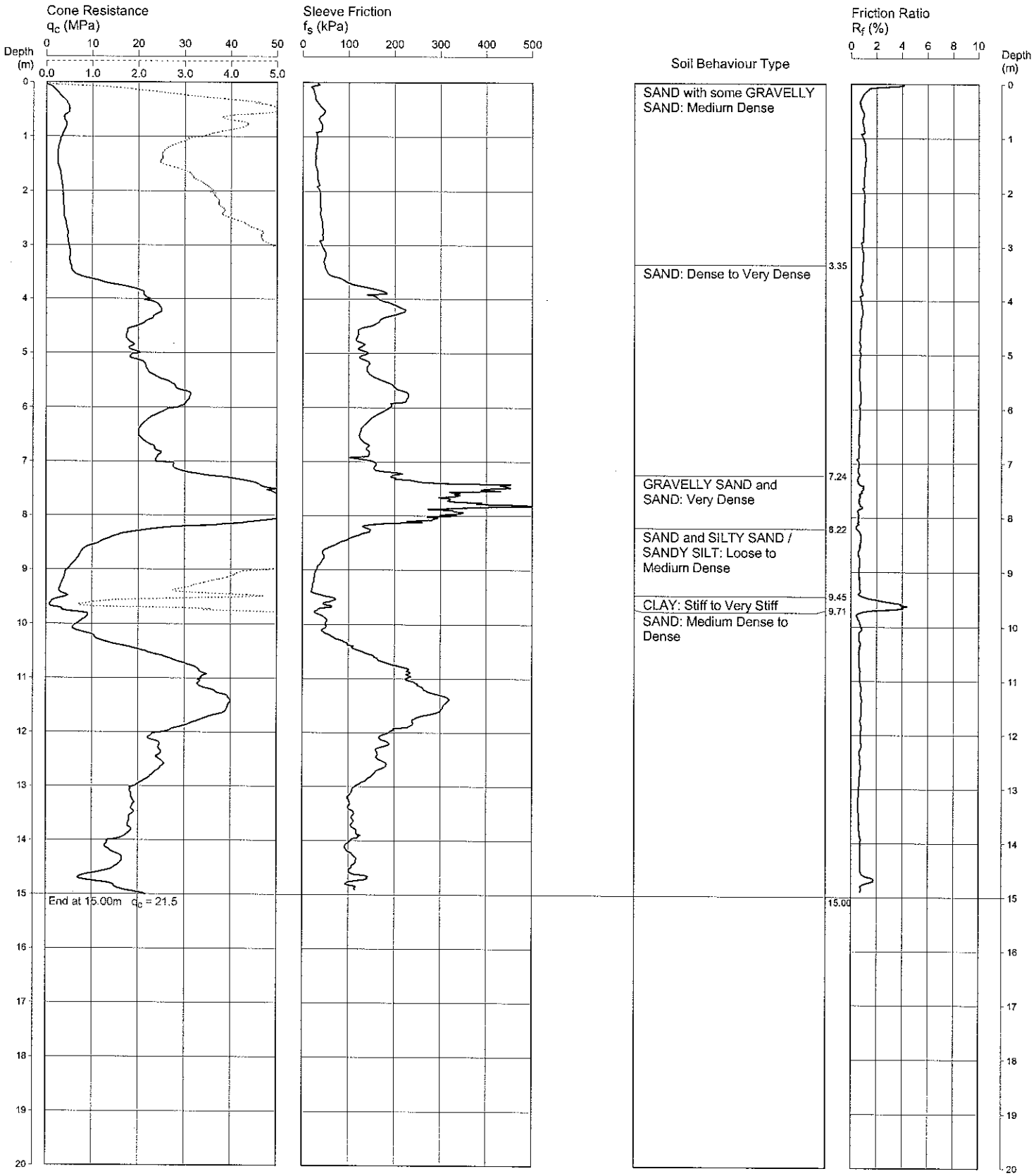
PROJECT No: 37673

CPT 105

Page 1 of 1

DATE 9/12/04

SURFACE RL: 5.1



REMARKS: HOLE COLLAPSE AT 4.2m
E 280217 N 1149810 (ISG) : E 297326 N 6148968 (MGA)

Date Plotted 3/01
Checked

File: D:\37673\CPT files\37673105.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.8.0

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

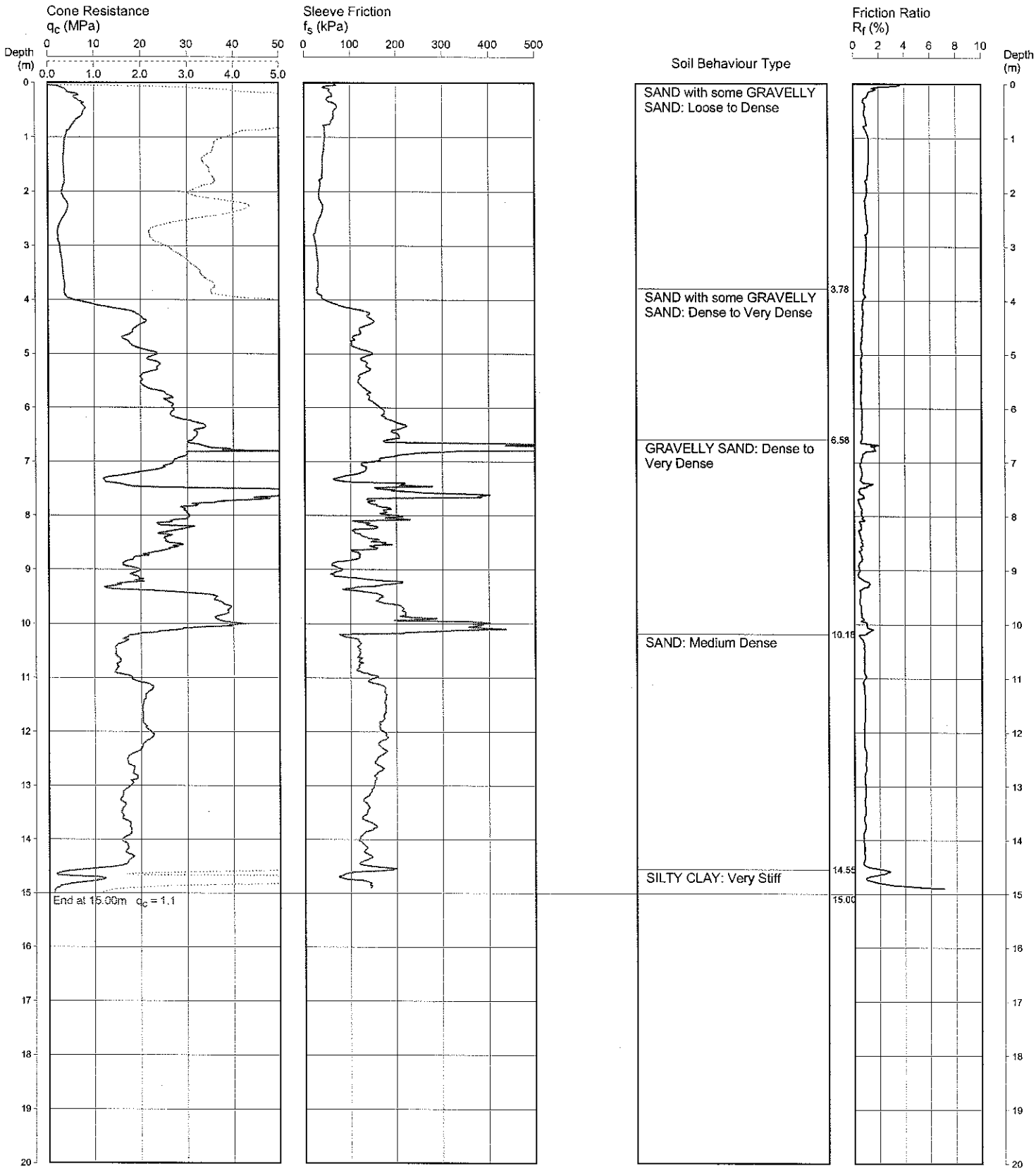
PROJECT No: 37673

CPT 106

Page 1 of 1

DATE 9/12/04

SURFACE RL: 6.8



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E 280156 N 1149686 (ISG) : E 297265 N 6148968 (MGA)

Date Plotted 5/05
Checked

File: N:\GEOTECHNICAL PROJECTS\376\37673\CPT files\37673106.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

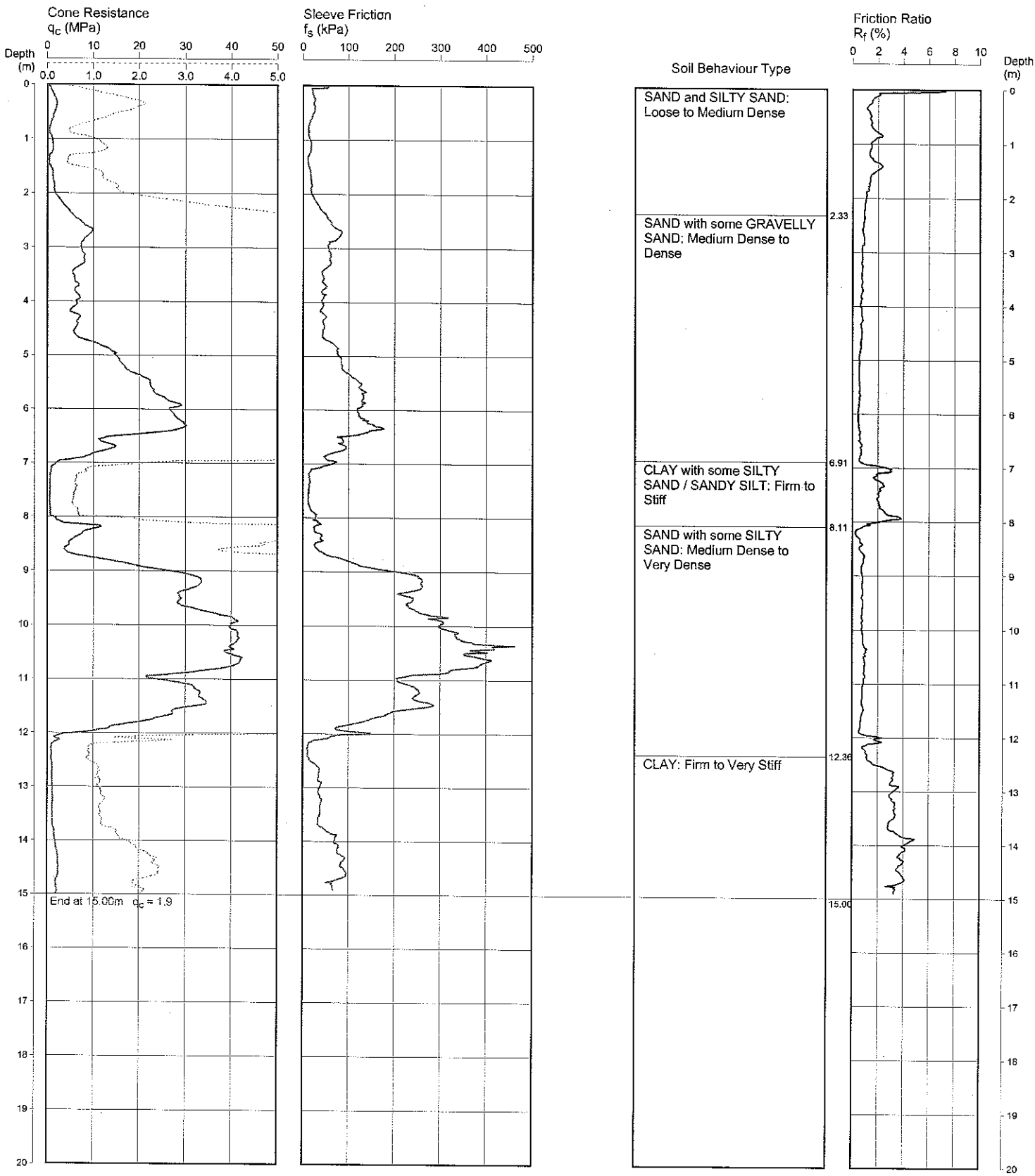
PROJECT No: 37673

CPT 107

Page 1 of 1

DATE 9/12/04

SURFACE RL: 4.1



REMARKS: HOLE COLLAPSE AT 1.85m
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Date Plotted 30/1
Checked

File: N:\GEOTECHNICAL PROJECTS\376\37673\CPT files\37673107.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GEROA & BEACH ROADS, GERROA

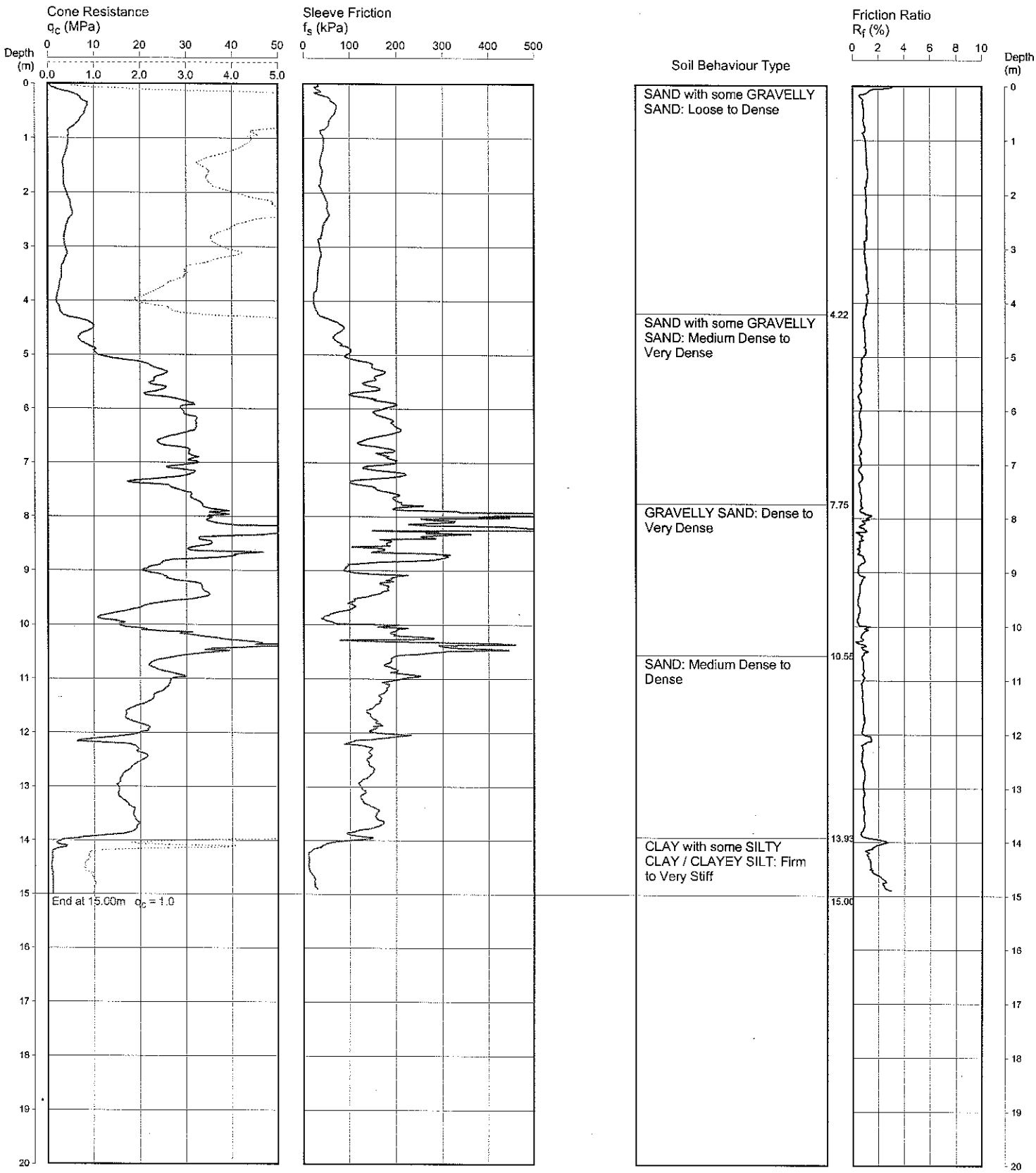
PROJECT No: 37673

CPT 108

Page 1 of 1

DATE 9/12/04

SURFACE RL: 6.8



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Date Plotted 3/05
Checked

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Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

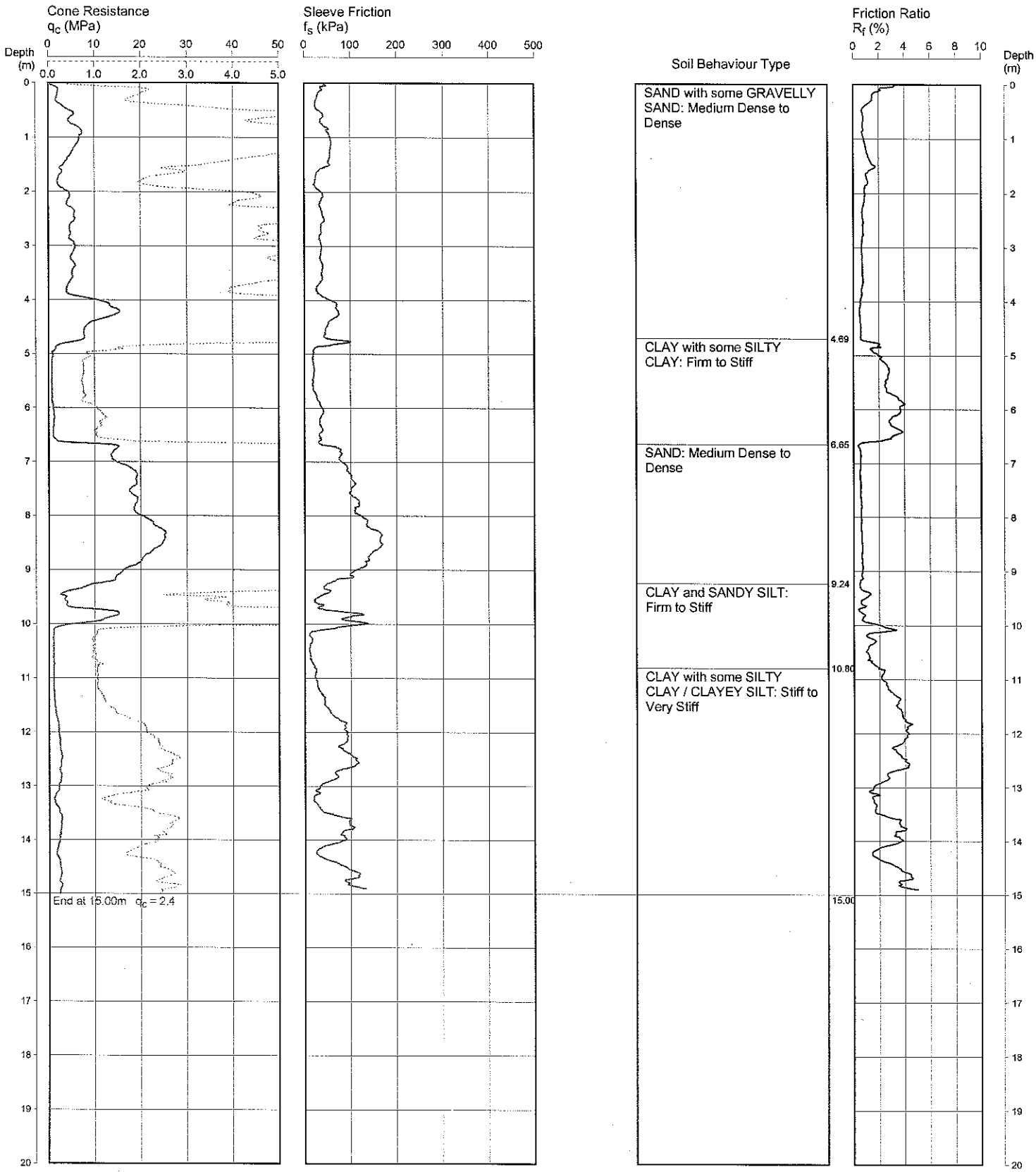
PROJECT No: 37673

CPT 109

Page 1 of 1

DATE 9/12/04

SURFACE RL: 2.5



REMARKS: HOLE COLLAPSE AT 0.65m
E 279893 N 1149711 (ISG) : E 297001 N 6148987 (MGA)

Date Plotted 3/05
Checked

File: N:\GEOTECHNICAL PROJECTS\376\37673\CPT files\37673109.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

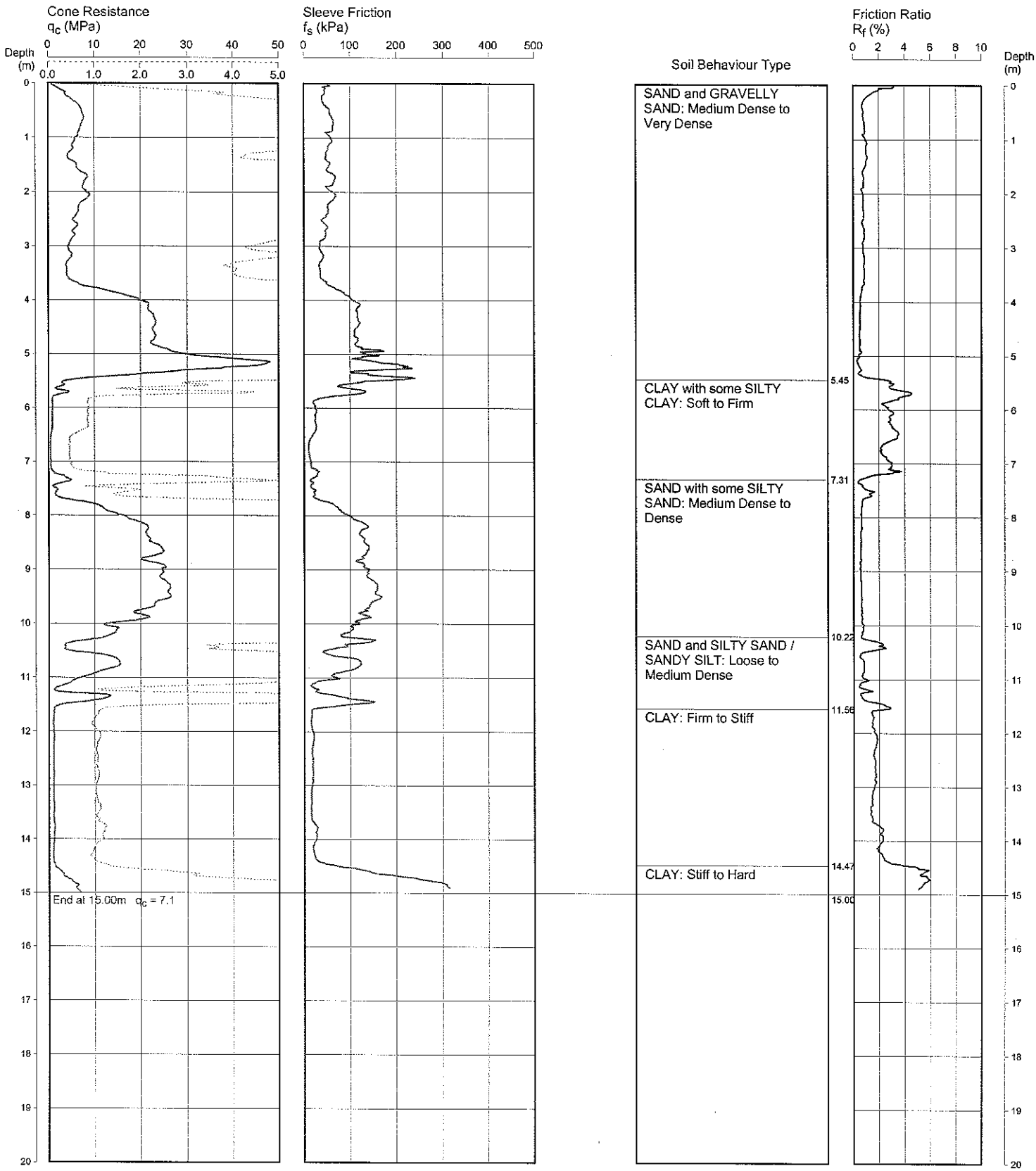
PROJECT No: 37673

CPT 110

Page 1 of 1

DATE 9/12/04

SURFACE RL: 2.4



REMARKS: HOLE COLLAPSE AT 1.3m
E 279924 N 1149617 (ISG) : E 297034 N 6148894 (MGA)

Date Plotted 3/01
Checked

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Cone ID: H3 Type: 2 Standard

ConePlot Version 5.2.4

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CONE PENETRATION TEST

CLIENT: CLEARY BROS (BOMBO) PTY LTD

PROJECT: PROPOSED NORTHERN EXTENSION

LOCATION: GERROA & BEACH ROADS, GERROA

PROJECT No: 37673

CPT 111

Page 1 of 1

DATE 9/12/04

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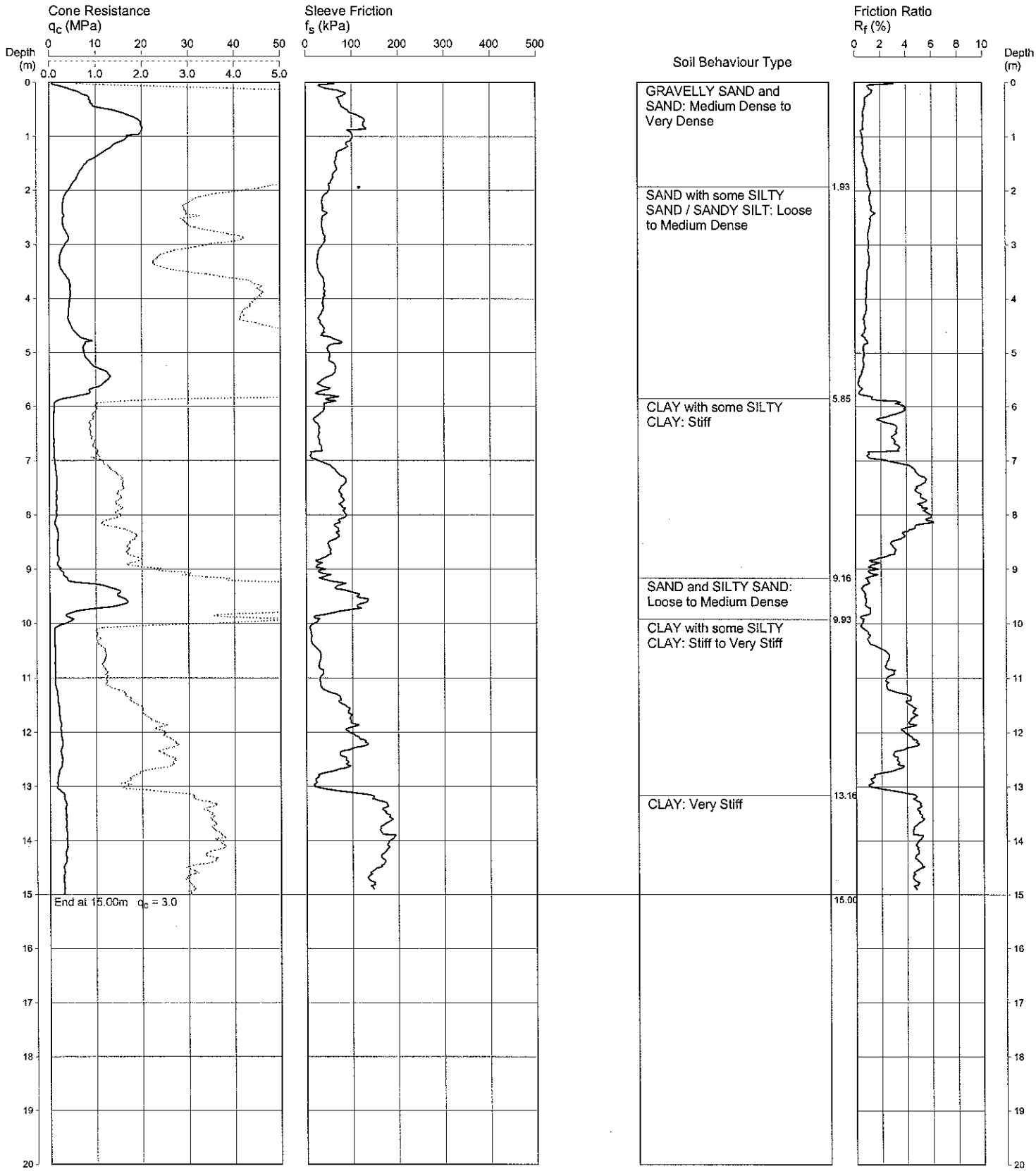

REMARKS: HOLE COLLAPSE AT 0.7m
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Date Plotted 3/05
Checked

File: D:\37673\CPT files\37673111.CP5
Cone ID: H3 **Type:** 2 Standard

ConePlot Version 5.8.0

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 4.5m
EASTING: 280456
NORTHING: 1149997
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 37673
DATE: 20 Dec 04
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SILTY SAND - grey brown silty sand, rootlets, damp (topsoil)							A			
	0.5	SILTY SAND - very loose, orange brown silty sand, rootlets, damp							S			2,2,2 N = 4
	1								A			
	2.0	SAND - loose, pale orange brown fine grained sand, rootlets, damp							S			2,3,3 N = 6
	3	- medium dense sand, moist to wet				▼			S			3,7,12 N = 19
	4	- medium dense, orange grey fine to medium grained sand, wet							S			6,7,9 N = 16
	5.0	GRAVELLY SAND - dense, orange grey coarse grained sand and subrounded quartz, siltstone, gravel with shell fragments, saturated							S			6,16,30 N = 46
	6								S			30 for 150mm,-,- refusal
	7	- very dense sand							S			19,23,28 N = 51
	8	- grey gravelly sand							S			11,14,19 N = 33

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 6.0m

TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 13.5m

WATER OBSERVATIONS: Free groundwater observed at 3.5m

REMARKS: E 297558 N 6149284 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 3/05

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 4.5m
EASTING: 280456
NORTHING: 1149997
DIP/AZIMUTH: 90°/--

BORE No: 201
PROJECT No: 37673
DATE: 20 Dec 04
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		- grey gravelly sand										
	9.25	SAND - dense, dark grey medium to coarse grained sand, saturated							S			25,25,16 N = 41
	10								S			12,16,25 N = 41
	11								S			13,18,26 N = 44
	12								S			16,24,25 N = 49
	12.8	SILTY SAND - medium dense, silty sand							S			10,11,13 N = 24
	13.5	Bore discontinued at 13.5m (refusal on possible weathered rock or very dense sand)										
	14											
	15											
	16											
	17											

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 6.0m

TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 13.5m

WATER OBSERVATIONS: Free groundwater observed at 3.5m

REMARKS: E 297558 N 6149284 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 5.1m
EASTING: 280320
NORTHING: 1149878
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 37673
DATE: 21 Dec 04
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SILTY SAND - grey brown silty sand (topsoil)										
	0.5	SILTY SAND - very loose, orange brown fine grained silty sand, rootlets, damp							A			
	1								A,S			2,2,2 N = 4
									A			
	2	- pale orange grey							S			1,1,1 N = 2
	3	- pale orange grey							S			-,1,3 N = 4
	3.3	SAND - medium dense, pale orange grey fine to medium grained sand, trace shell fragments, wet				▼						
	4								S			2,7,10 N = 17
	5								S			4,11,17 N = 28
	6	- very dense, orange grey fine to medium grained sand with some shells, shell fragments, saturated							S			16,25,25 N = 50
	7	- slightly coarse grained							S			15,26,25 N = 51
	7.5	GRAVELLY SAND - grey coarse grained sand and subrounded quartz, siltstone gravel with shells and shell fragments, saturated										
	8								S			18,30,- refusal

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 8.5m
TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 15.2m
WATER OBSERVATIONS: Free groundwater observed at 3.8m
REMARKS: E 297425 N 6149163 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 7/1/05

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 5.1m
EASTING: 280320
NORTHING: 1149878
DIP/AZIMUTH: 90°/--

BORE No: 202
PROJECT No: 37673
DATE: 21 Dec 04
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	9.1	SAND - dense, dark grey medium to coarse grained sand, trace gravel, possibly slightly organic, saturated							S			7,4,5 N = 9
	10								S			12,20,26 N = 46
	11	- grey, non organic							S			12,17,20 N = 37
	12 12.0	GRAVELLY SAND - dark grey coarse grained sand and subrounded quartz, siltstone gravel with shells and shell fragments, saturated							S			10,21,30 for 100mm refusal
	13 13.0	SAND - dense, grey coarse grained sand, saturated							S			14,21,26 N = 47
	14								S			13,23,26 N = 49
	15								S			19,25 for 50mm,-refusal
	15.2	Bore discontinued at 15.2m (limit of investigation)										
	16											
	17											

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 8.5m

TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 15.2m

WATER OBSERVATIONS: Free groundwater observed at 3.8m

REMARKS: E 297425 N 6149163 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 7/01

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 6.0m
EASTING: 280219
NORTHING: 1149752
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 37673
DATE: 22 Dec 04
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
	0.2	SILTY SAND - grey brown silty sand, rootlets, damp (topsoil)										
		SILTY SAND - very loose, orange brown silty sand, rootlets, damp to moist							A			
	1								A,S			2,1,2 N = 3
									A			
	2								S			2,2,3 N = 5
	3	- loose sand							S			2,3,3 N = 6
	4	- medium dense sand, no rootlets				▼			S			1,3,8 N = 11
	5								S			3,6,4 N = 10
	6								S			4,5,4 N = 9
	6.0	SAND - loose, orange brown fine grained sand, wet										
	7								S			20 for 0.5mm,-,- refusal
	7.05	GRAVELLY SAND - orange grey coarse grained sand and subrounded quartz, siltstone gravel with shells and shell fragments, saturated										
	8	- medium dense sand, trace cobbles							S			15,13,12 N = 25

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 5.5m

TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 17.5m

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS: E 297 326 N 6149035 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 6.0m
EASTING: 280219
NORTHING: 1149752
DIP/AZIMUTH: 90°/--

BORE No: 203
PROJECT No: 37673
DATE: 22 Dec 04
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		GRAVELLY SAND - orange grey coarse grained sand and subrounded quartz, siltstone gravel with shells and shell fragments, saturated *(continued)*							S			5,3,5 N = 8
		└ loose sand										
	10	- medium dense, dark brown and grey sand, trace organics, saturated							S			14,8,12 N = 20
	11	11.0 SAND - dense, dark grey brown medium to coarse grained sand, trace organics, saturated							S			11,16,20 N = 36
	12								S			21,25 for 80mm,- refusal
	13	- trace gravel and shell fragments							S			20,30 for 100mm,- refusal
	14	- grey medium grained sand, trace shell fragments							S			18,25 for 100,- refusal
	15	- grey medium grained sand							S			15,30 for 80mm,- refusal
	16											
		16.5 CLAY - grey clay										
	17											
		17.5 Bore discontinued at 17.5m (limit of investigation)										

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 5.5m

TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 17.5m

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS: E 297 326 N 6149035 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▽ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 5.8m
EASTING: 280102
NORTHING: 1149688
DIP/AZIMUTH: 90°/--

BORE No: 204
PROJECT No: 37673
DATE: 21 Dec 04
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		SILTY SAND - grey brown silty sand, rootlets, damp (topsoil)							A			
	0.6	SILTY SAND - very loose, orange brown silty sand, damp, rootlets							A,S			2,2,2 N = 4
	1	- no rootlets							A			
	2	- no rootlets, wet							S			1,2,2 N = 4
	3								S			1,2,1 N = 3
	4	- loose sand, no rootlets				▼			S			1,4,5 N = 9
	5	- rootlets, wet							S			2,2,2 N = 4
	6	6.0 SAND - dense, orange brown and grey fine to medium grained san, trace shell fragments, saturated							S			10,19,18 N = 37
	7	- with some shell fragments							S			20,25 for 80mm,- refusal
	8	8.0 GRAVELLY SAND - orange grey coarse grained sand and subrounded quartz and siltstone gravel, trace cobbles with some shells and shell fragments, saturated							S			20,25 for 100mm,- refusal

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 9.0m
TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 15.5m
WATER OBSERVATIONS: Free groundwater observed at 4.0m
REMARKS: E 297210 N 6148968 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Cleary Bros (Bombo) Pty Ltd
PROJECT: Proposed Northern Extension
LOCATION: Gerroa Sand Quarry, Gerroa

SURFACE LEVEL: 5.8m
EASTING: 280102
NORTHING: 1149688
DIP/AZIMUTH: 90°/--

BORE No: 204
PROJECT No: 37673
DATE: 21 Dec 04
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Degree of Weathering (EW HW MW SW FS FR)	Graphic Log	Rock Strength (Ex Low, Very Low, Low, Medium, High, Very High, Ex High)	Water	Fracture Spacing (m) (0.01, 0.05, 0.10, 0.50, 1.00)	Discontinuities (B - Bedding, J - Joint, S - Shear, D - Drill Break)	Sampling & In Situ Testing: Type	Core Rec. %	RQD %	Test Results & Comments
		GRAVELLY SAND - orange grey coarse grained sand and subrounded quartz and siltstone gravel, trace cobbles with some shells and shell fragments, saturated *(continued)*										
	10 10.0	SAND - medium dense, dark brown grey coarse grained sand, with some gravel, shell fragments, trace organics, cobbles, saturated							S			11,10,9 N = 19
	11	- dense sand							S			12,19,26 N = 45
	12	- dense sand, slightly gravelly, no organics							S			11,19,30 N = 49
	13	- grey, trace gravel, no shell fragments or organics							S			14,23,25 for 100mm refusal
	14								S			
	14.6	CLAY - soft, grey clay, damp										
	15								S			
	15.45	Bore discontinued at 15.45m (limit of investigation)										
	16											
	17											

RIG: Scout **DRILLER:** Driver **LOGGED:** L McKenzie **CASING:** to 9.0m

TYPE OF BORING: Spiral flight auger to 5.5m; Rotary to 15.5m

WATER OBSERVATIONS: Free groundwater observed at 4.0m

REMARKS: E 297210 N 6148968 (MGA)

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo Ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date: 3/05

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DESCRIPTIVE GEOLOGICAL LOG

Drill Hole Reference: CB#201

Collar Height: 0.6 m AHD

Water Table: 0.1 m

Sample Interval (m)	Description
0.0 - 2.5	SAND, fawn, fine grained, well sorted, subangular-subrounded, quartzose sand. Light to medium iron stain on 30% of quartz grains. Trace lithics, no shell.
2.5 - 5.4	SAND, grey, very fine-medium grained (some coarse grained), subangular-subrounded, moderately sorted, quartzose sand. 5% shell occurring as fragments of medium-coarse grained marine shells. Occasional quartz and lithic pebbles, and thin interbedded gravel layers. 10% lithics. Many quartz grains have black (light to moderate) coating.
5.4 - 6.3	SAND, grey-brown, very fine-coarse grained (some very coarse grained), subangular-rounded, poorly sorted, quartzose sand. Trace shell, 5% lithics. Light organic (brown) coating on 5% of quartz grains.
6.3 - 6.5	CLAY, dark grey/black, plastic clay.

End of hole: - 5.9 m AHD

DESCRIPTIVE GEOLOGICAL LOG

Drill Hole Reference: CB#204

Collar Height: 0.87 m AHD

Water Table: At or near surface

Sample Interval (m)	Description
0.0 - 0.6	SAND, light grey, fine grained, well sorted, subangular-subrounded quartzose sand. No shell, trace lithics.
0.6 - 1.4	SAND, grey, fine-medium grained, well sorted, subangular-subrounded quartzose sand. Slightly muddy with occasional coarse grained quartz grains. <5% lithics, no shell.
1.4 - 5.3	SAND, grey, medium-coarse grained, poorly sorted, subangular-subrounded (coarse grained-very coarse grained is subrounded-rounded) quartzose sand. Clean becoming very slightly muddy with depth. Interbedded very coarse grained sand and pebble layers. 5% lithics. Trace shell occurring as medium-very coarse grained abraded fragments of marine shell.
5.3 - 5.5	CLAY, dark grey/black plastic clay.

End of hole: - 4.63 m AHD

DESCRIPTIVE GEOLOGICAL LOG

Drill Hole Reference: CB#206

Collar Height: 4.78 m AHD

Water Table: 4.5 m

Sample Interval (m)	Description
0.0 - 5.5	SAND, fawn brown becoming fawn below 1.4m, fine grained, well sorted, subangular-subrounded quartzose sand. Light to moderate iron staining on 20-30% of quartzose grains. Trace lithics, no shell.
5.5 - 7.9	SAND, grey fawn, fine-medium grained, well sorted, subangular-subrounded quartzose sand with scattered pebbles and gravel. 5%-10% shell as medium-very coarse grained and larger abraded and whole marine shell (bankivia etc). Trace lithics. Light to heavy iron staining on 30-40% of quartz grains.
7.9 - 9.7	SAND, fawn to light brown fawn, fine-coarse grained, poorly sorted, subangular-subrounded quartzose sand with pebbles. Trace lithics. 5% shell as medium-very coarse grained abraded fragments and larger whole marine shell. Light to moderate iron staining on 10% of grains.
9.7 - 12.0	SAND, grey brown to brown grey, fine-medium grained, well sorted, subangular-subrounded quartzose sand. Becomes finer with depth. No shell, trace lithics. Interbedded fine and medium grained sands.
12.0 - 13.8	SAND, Brown grey, fine-coarse grained, moderately sorted, subangular-subrounded, quartoze sand. No shell, trace lithics.
13.8 - 14.0	CLAY, dark grey/black plastic clay.

End of hole: - 9.22 m AHD

5.5-7 m	Sand - light grey, coarse grained, high shell content. Becomes darker in colour, coarser grained and higher in shell with depth.
7-8.5 m	Sand - medium grained, highly shelly numerous small whole shells.
8.5-10 m	Sand - very coarse grained, rounded grains, low shell content.
10-11.5 m	Clay - grey, plastic, moist.

Hole SM4

0-1.5 m	Sand - cream, very fine grained sand.
1.5-3 m	Sand - cream, high shell content, fine grained.
3-4.5 m	Sand - coarse grained, higher shell content cream to yellow sand.
4.5-6 m	Sand - medium to coarse grained, small whole and fragmented shells, grey, slightly clayey.
6-9 m	Sand - very coarse grained, gritty, composed of shell and quartz grains, difficult to penetrate.

Hole SM5

0-1.5 m	Sand - very fine grained, cream to yellow, free of shell.
1.5-3 m	Sand - cream, becoming "cleaner" with depth.
3-4.5 m	Sand - grey, fine grained, becomes more shelly with depth.
4.5-6 m	Sand - grey, medium to coarse grained high shell content in the form of whole and fragmented shell. Scattered quartz pebbles.
6-7.5 m	Sand - coarse sand intermixed with fine sand, shell throughout.
7.5-9 m	Sand - clean, coarse grained, becoming more gritty towards base of hole. High shell content (whole and fragmented shell). Scattered quartz pebbles (up to 5 cm long).

Hole SM6

0-1.5 m	Sand - orange, very fine grained.
1.5-3 m	Sand cream-orange, very fine grained, no shell or clay.

3-4.5 m	Sand - cream to yellow, fine to medium grained, little shell, moist.
4.5-6 m	Sand - medium to coarse grained, low shell in the form of scattered fragments, grey.
6-9 m	Sand - very coarse grained, becoming more gritty with depth. Shell content increasing with depth. Poorly sorted, large scattered quartz pebbles. Mud - clay at base of hole.

Hole SM7

0-1.5 m	Sand - orange, medium to coarse grained.
1.5-3 m	Sand - medium to coarse grained, yellow - orange.
3.0-4.5 m	Sand - coarse and gritty, clean rounded grains.
4.5-6 m	Sand - white to cream, very coarse grained, high charcoal content. Little shell.
6 7 5 m	Sand - medium to coarse grained, poorly sorted.
7.5-9 m	Clay - plastic moist, black - grey. No shell, slightly sandy.

Hole SM8

0-1.5 m	Sand - cream to yellow, fine grained, no shell.
1.5-3 m	Sand - medium grained, yellow - orange.
3-4.5 m	Sand - medium grained, grey, minor shell content (fragmented).
4.5-6 m	Sand - grey, medium grained, poorly sorted, uneven grainsize, fragmented shells throughout.
6-7.5 m	Sand - very high shell content (small whole shells and fragments) coarse grained poorly sorted, grey.
7.5-9 m	Sand - coarser grained shelly as above.
9-10.5 m	Sand - very coarse grained, fine gravel, lithic clasts, pebbles up to 5 cm in length composed of sandstone, chert, quartz. All clasts are well rounded, mixed with small shells and shell fragments. Occasional clasts up to 10 cm in length. Some charcoal.

APPENDIX B
Results of Current Laboratory Physical Testing

Douglas Partners
Geotechnics · Environment · Groundwater

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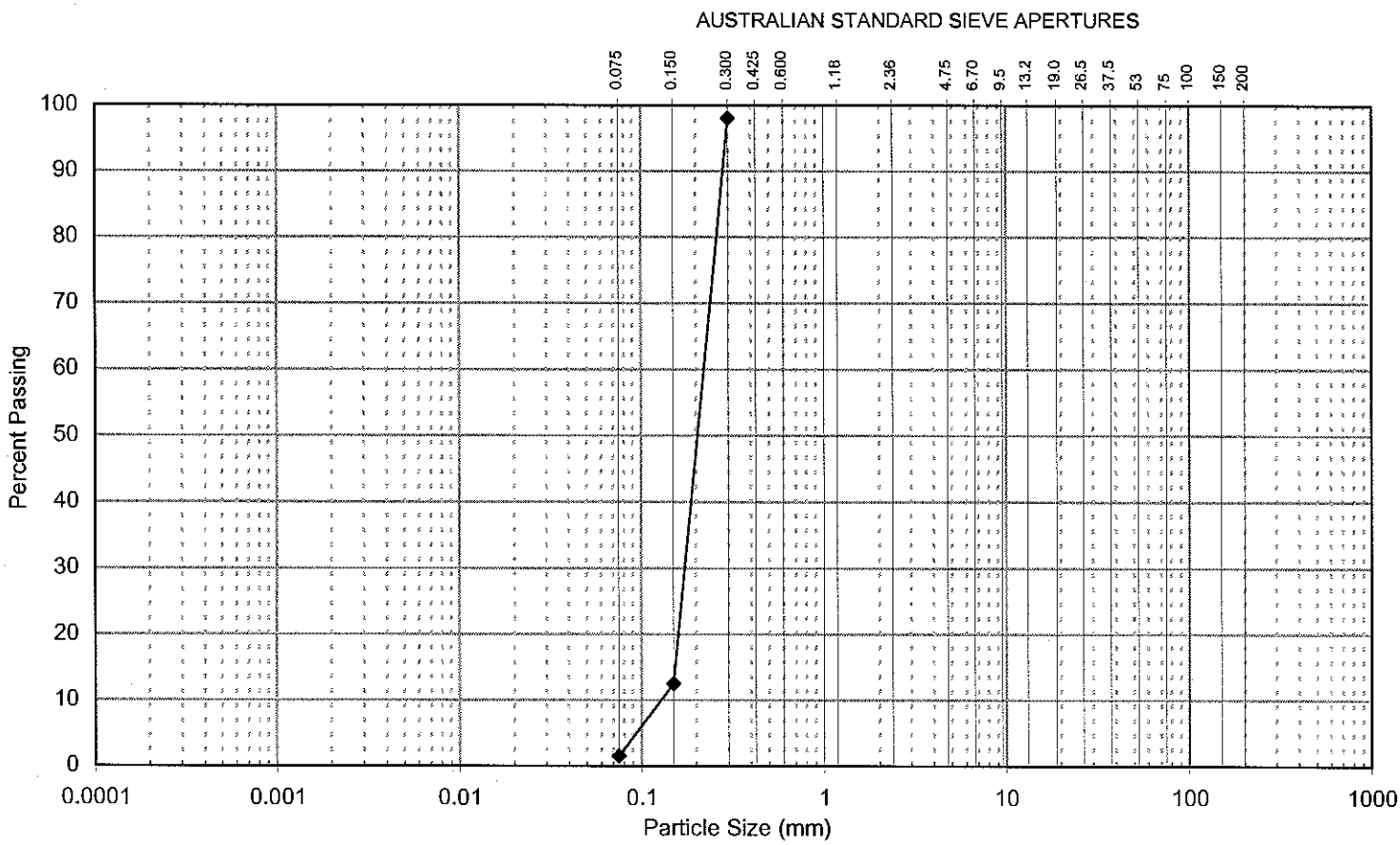
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004A
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 201	**Date of Test:**	6/01/2005
Depth / Layer :	1.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA Accredited Laboratory No 11183
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full

Approved Signatory:

Tested:	PB
Checked:	DE

David Evans
Laboratory Manager

Douglas Partners
Geotechnics · Environment · Groundwater

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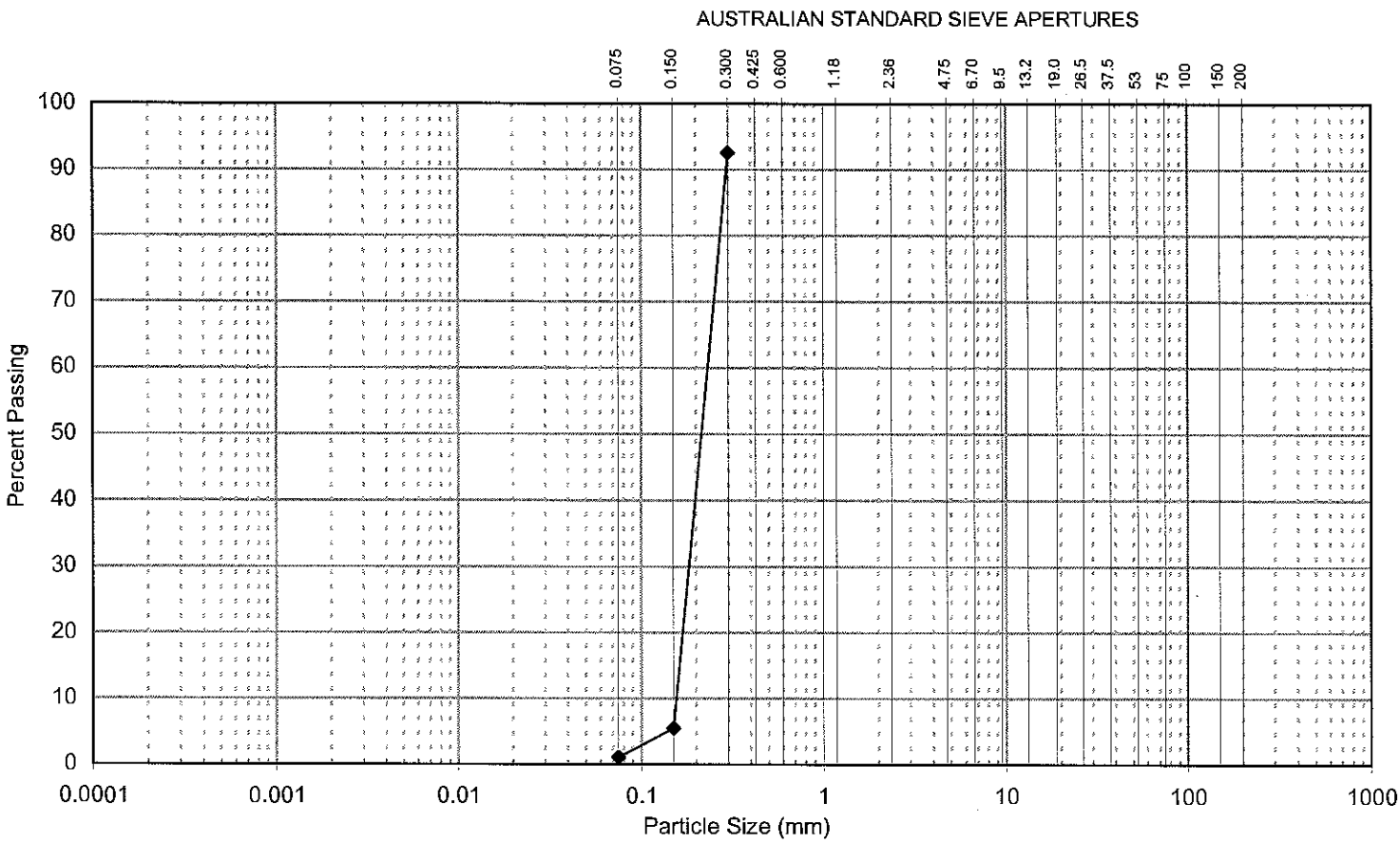
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004B
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 201	**Date of Test:**	6/01/2005
Depth / Layer :	2.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Yellow sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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Approved Signatory:

Tested:	PB
Checked:	DE

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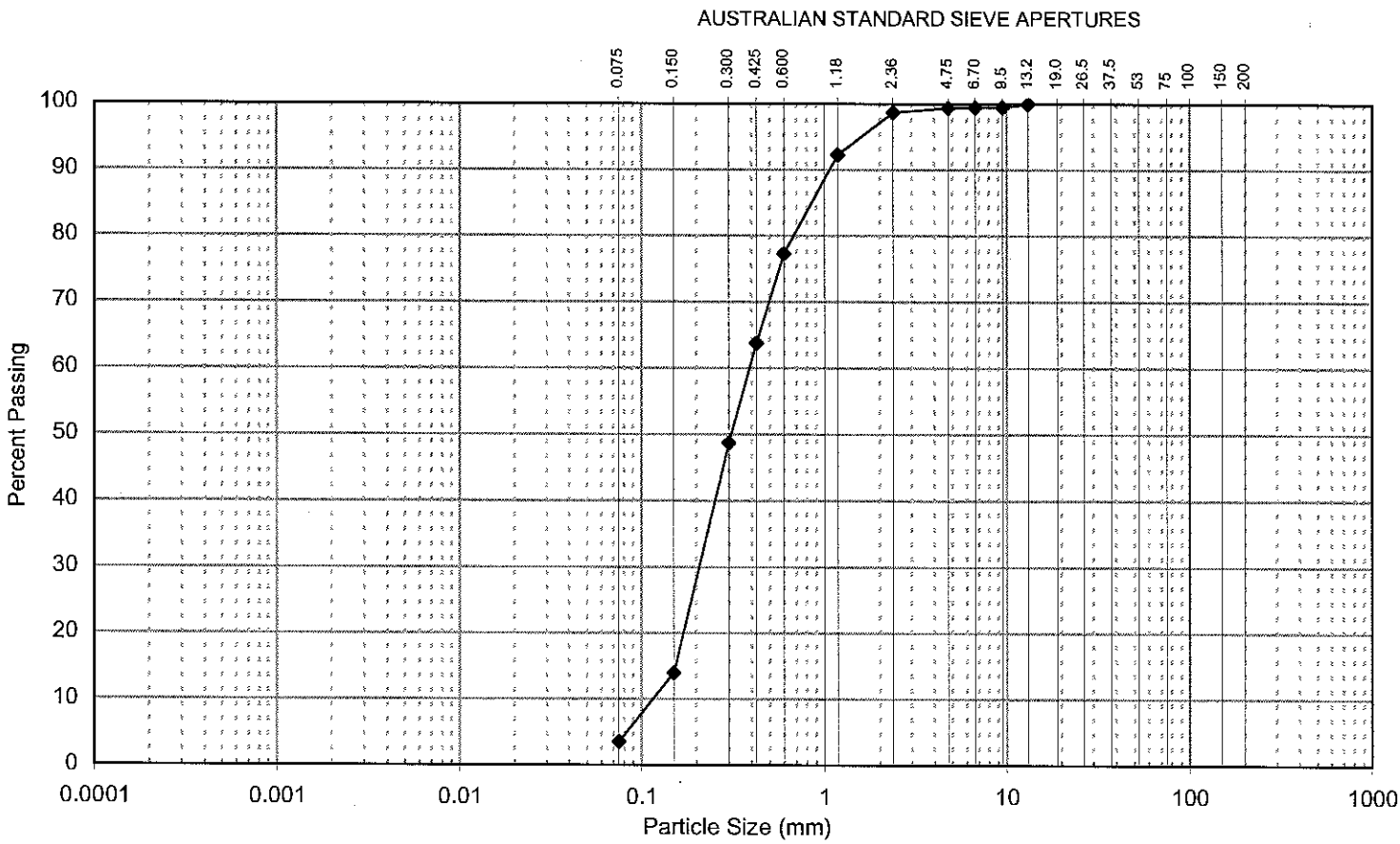
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004C
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 201	**Date of Test:**	6/01/2005
Depth / Layer :	8.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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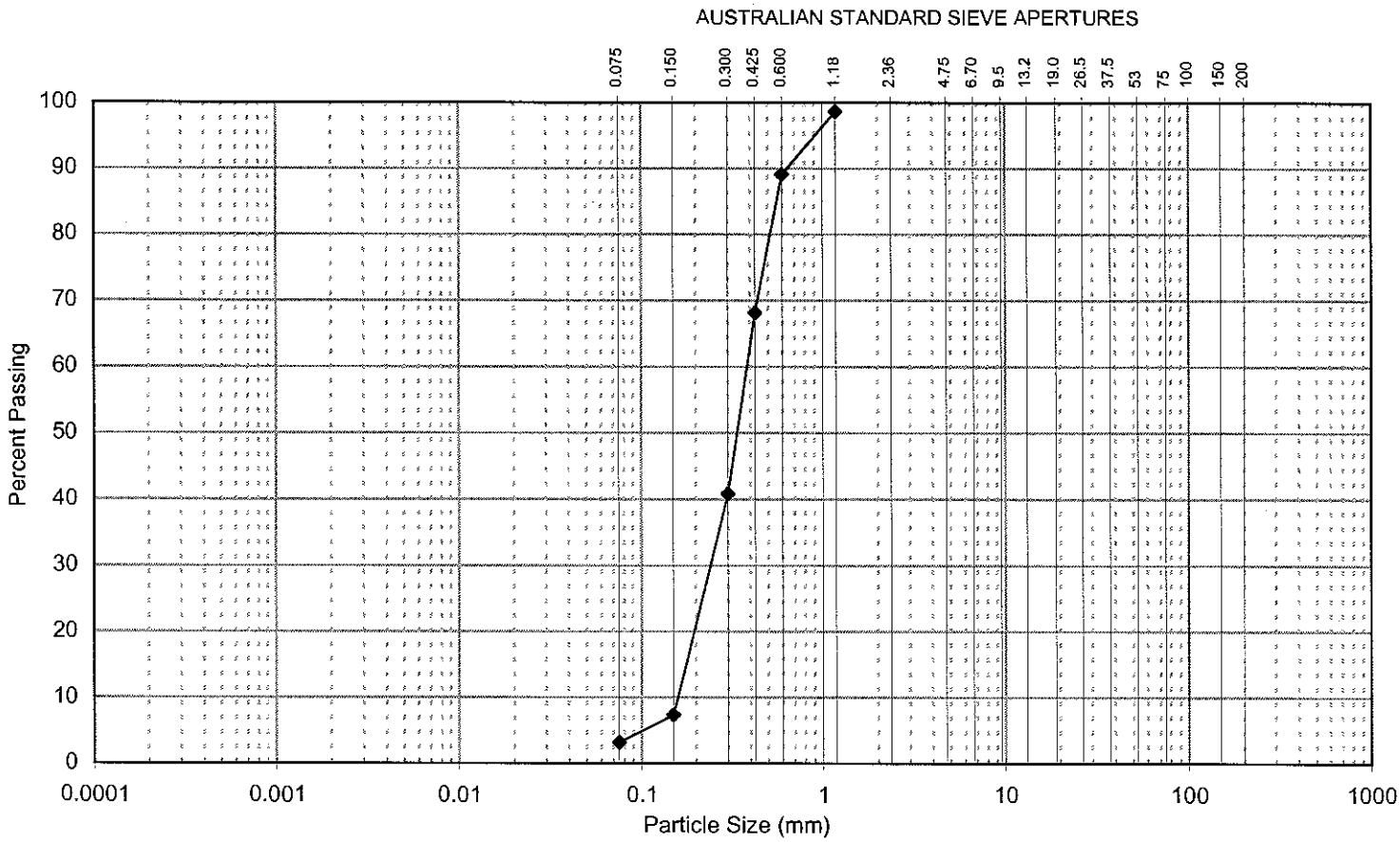
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004D
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 201	**Date of Test:**	6/01/2005
Depth / Layer :	11.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Grey sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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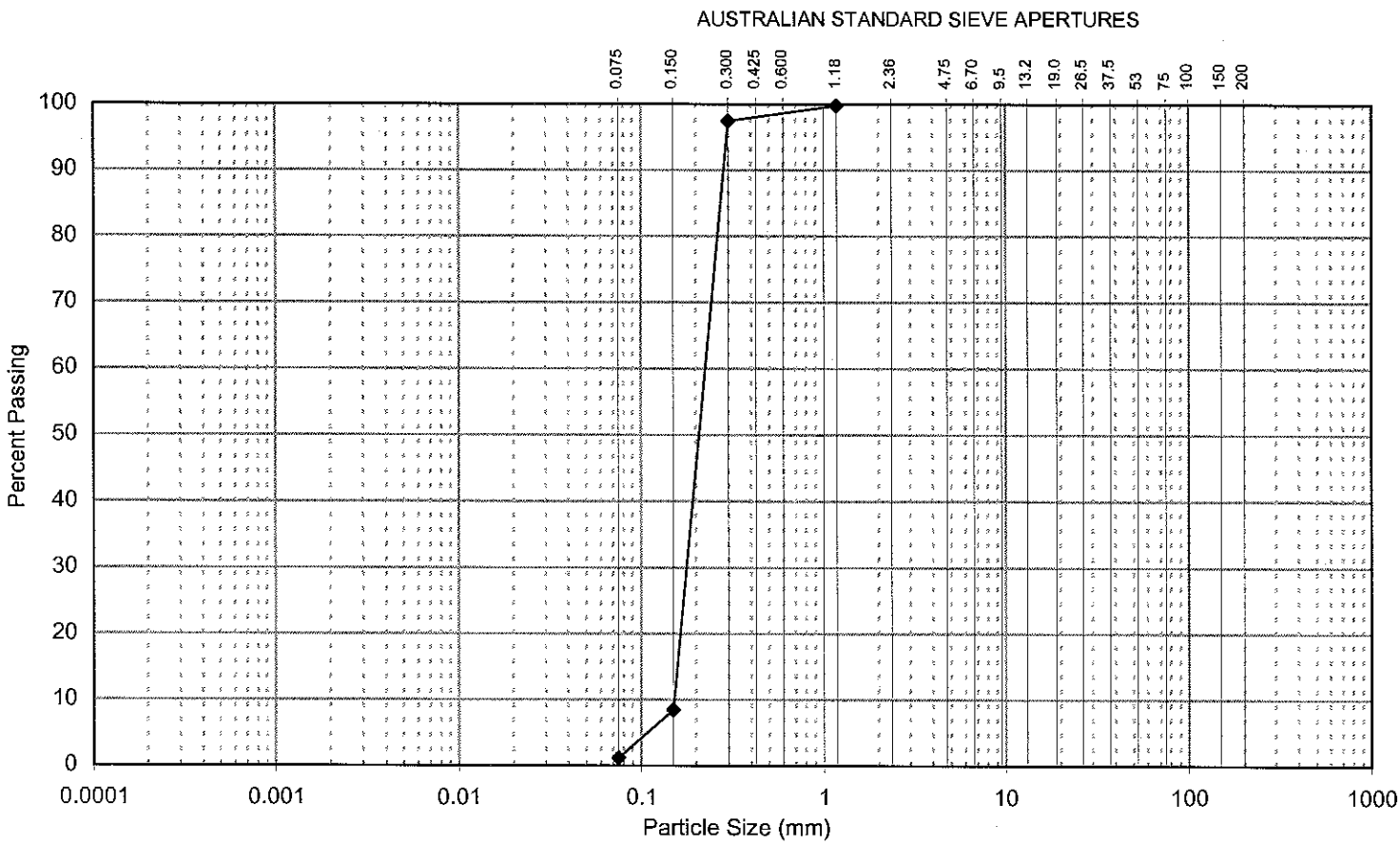
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004E
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 202	**Date of Test:**	6/01/2005
Depth / Layer :	1.5m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Yellow brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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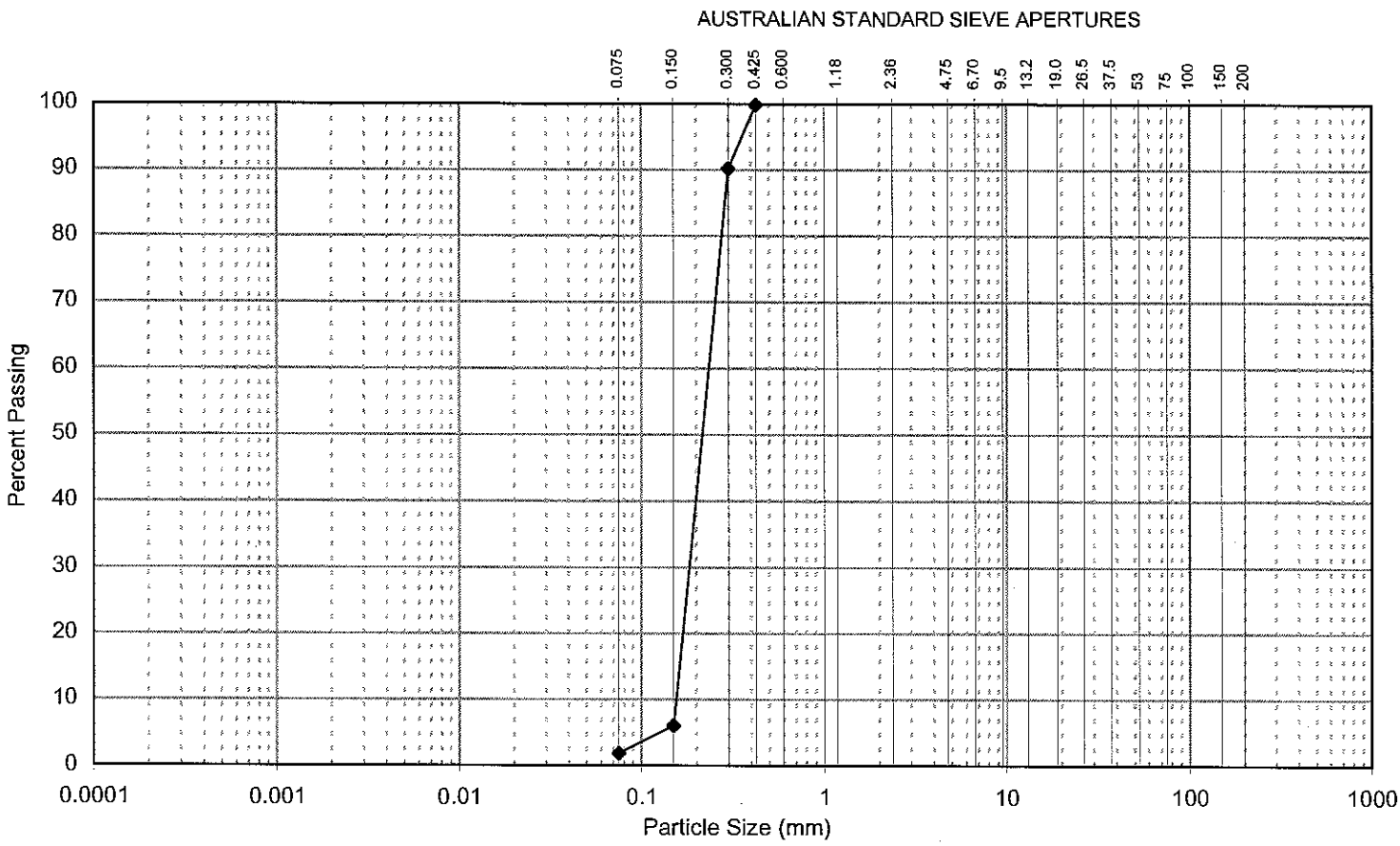
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004F
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 202	**Date of Test:**	6/01/2005
Depth / Layer :	3.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Yellow sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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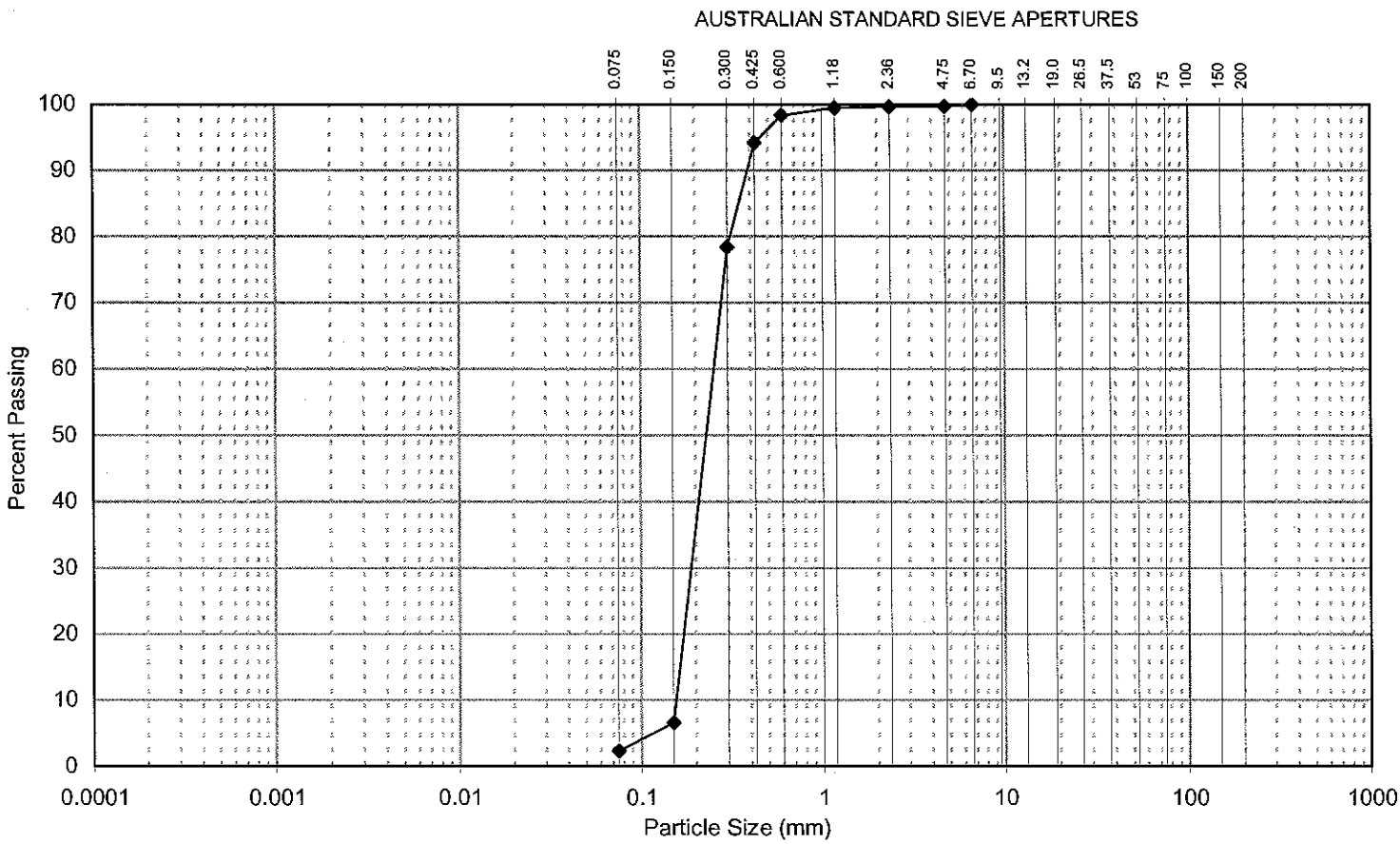
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004G
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 202	**Date of Test:**	6/01/2005
Depth / Layer :	5.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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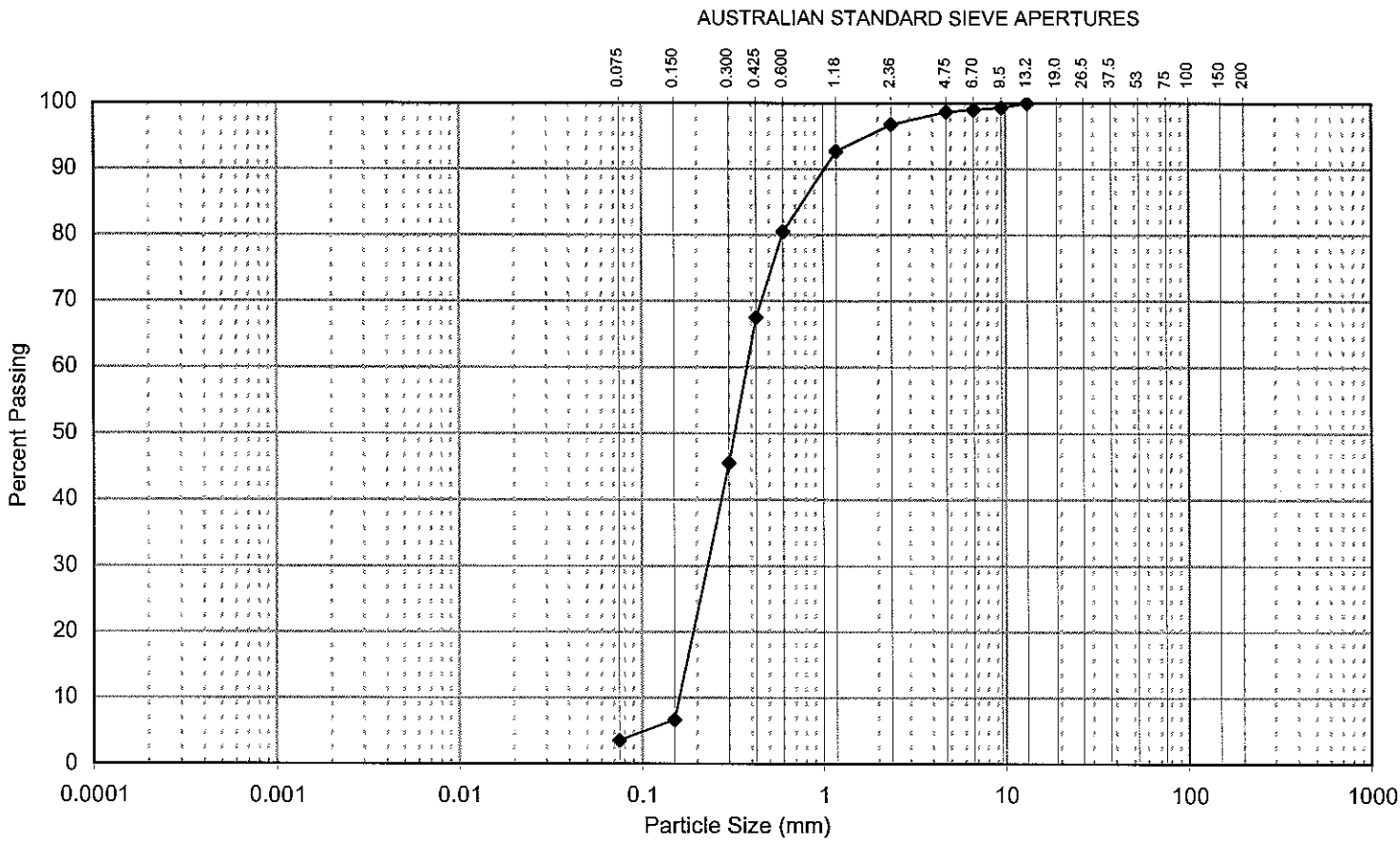
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004H
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 202	**Date of Test:**	6/01/2005
Depth / Layer :	7.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Yellow brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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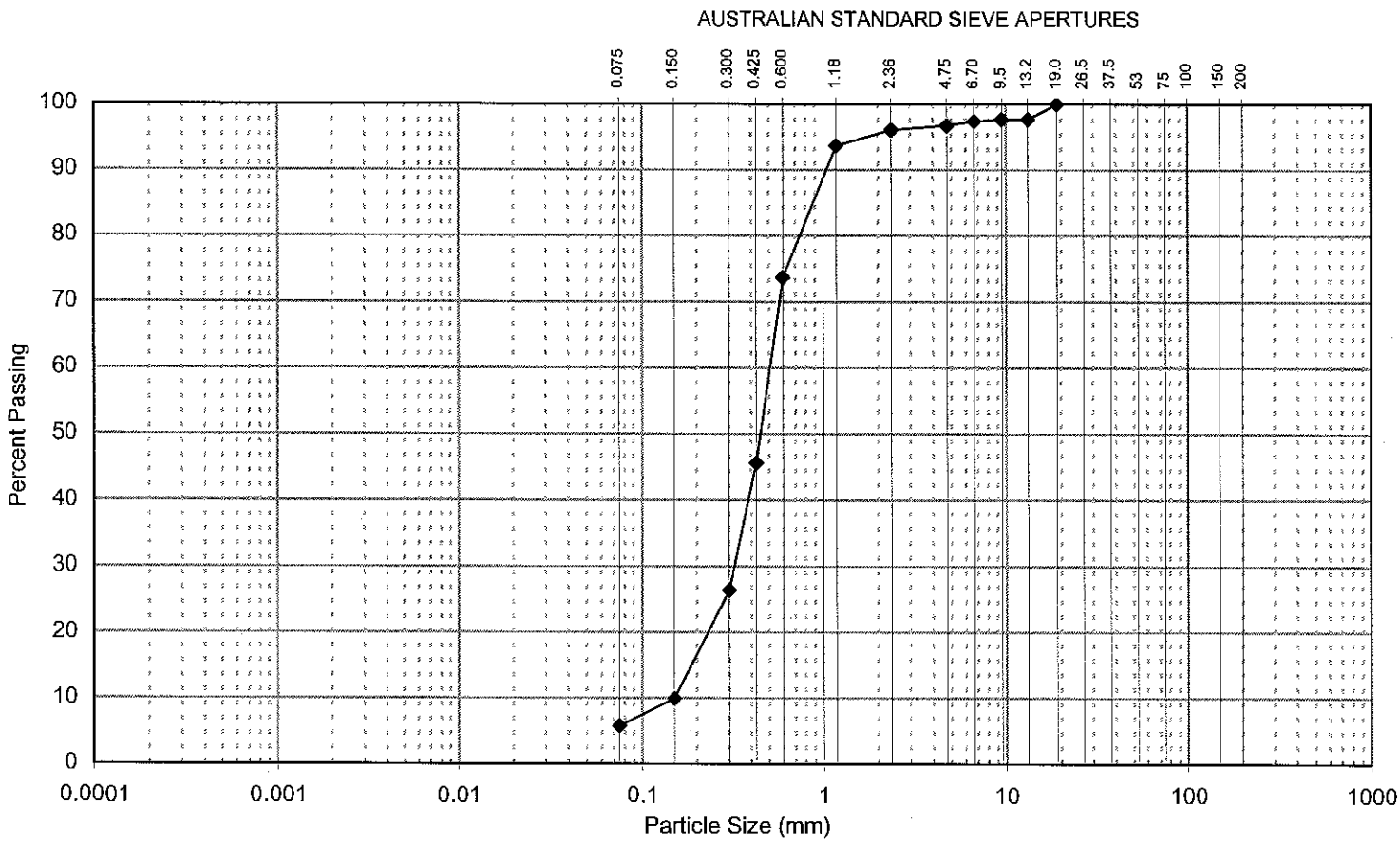
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004I
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 202	**Date of Test:**	6/01/2005
Depth / Layer :	10.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Dark grey sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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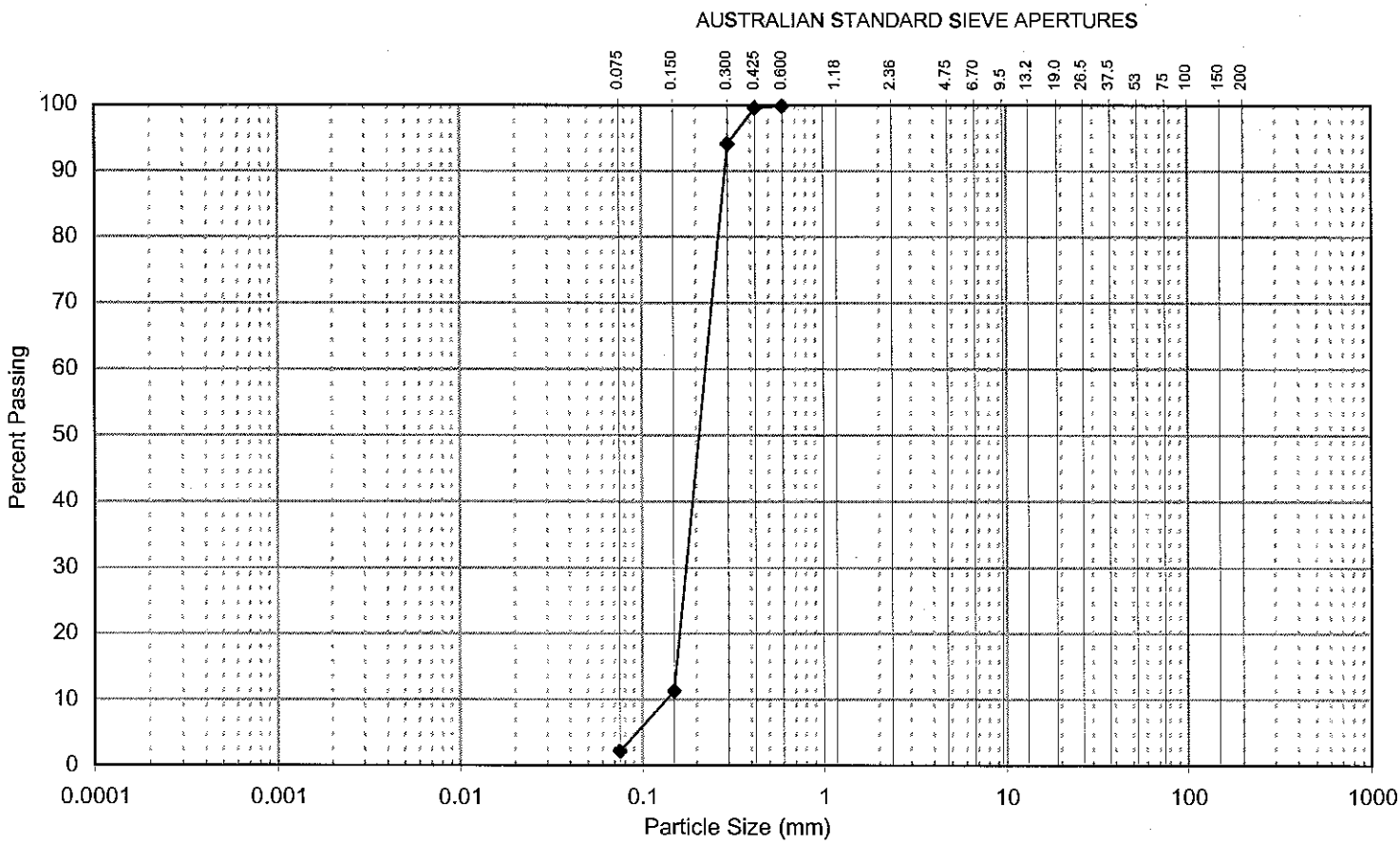
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004J
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 203	**Date of Test:**	6/01/2005
Depth / Layer :	2.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: Yellow sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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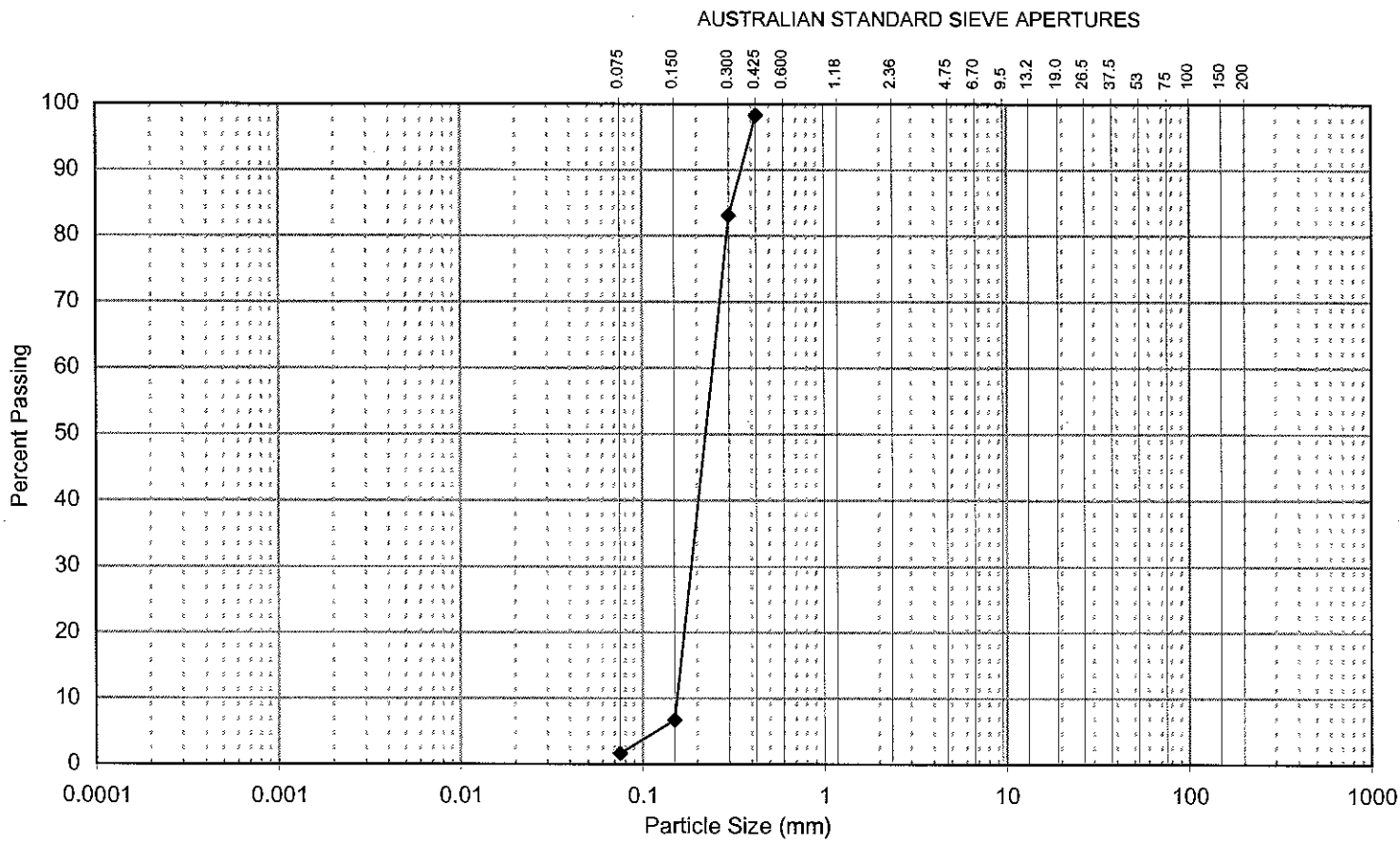
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004K
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 203	**Date of Test:**	6/01/2005
Depth / Layer :	6.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Yellow brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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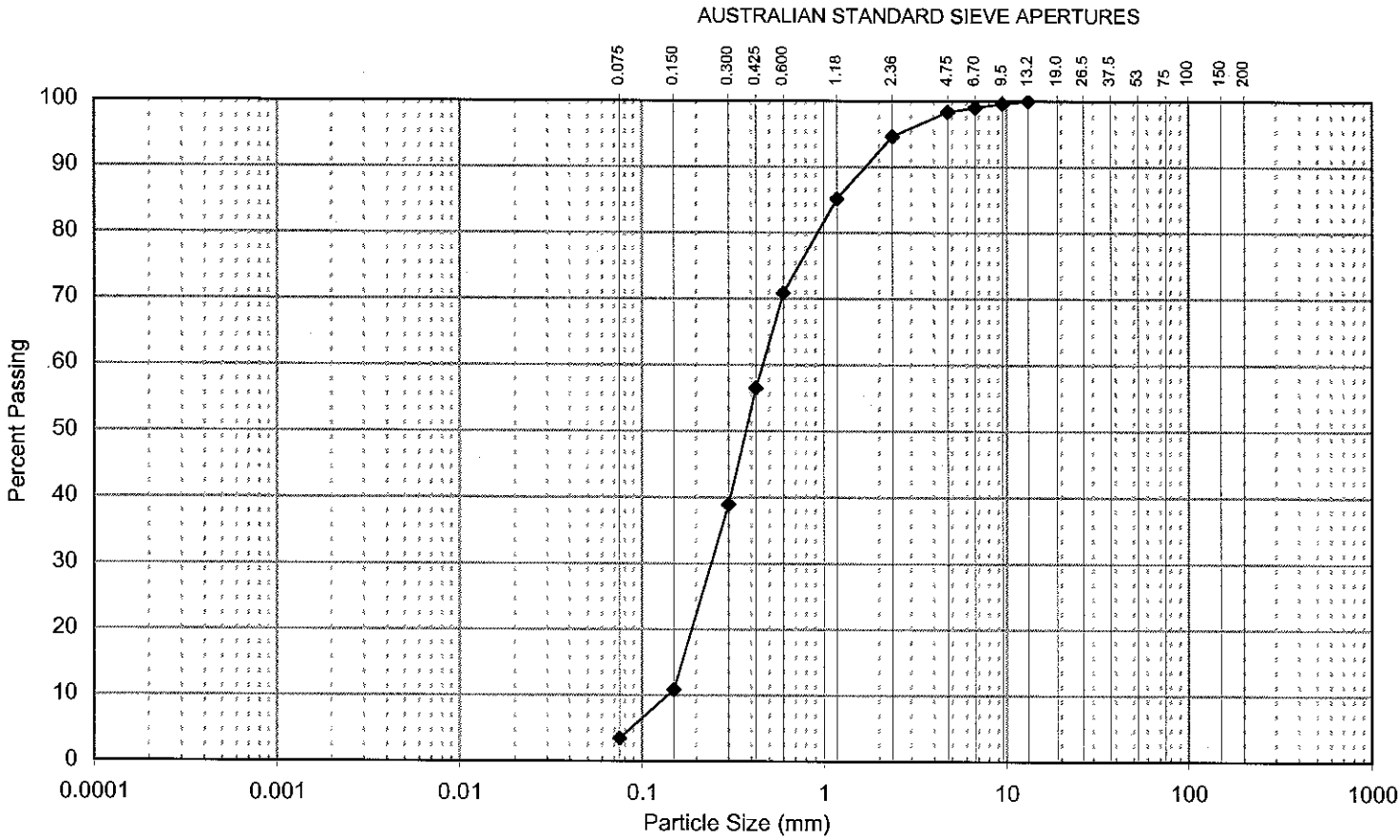
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004L
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 203	**Date of Test:**	6/01/2005
Depth / Layer :	9.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Brown gravelly sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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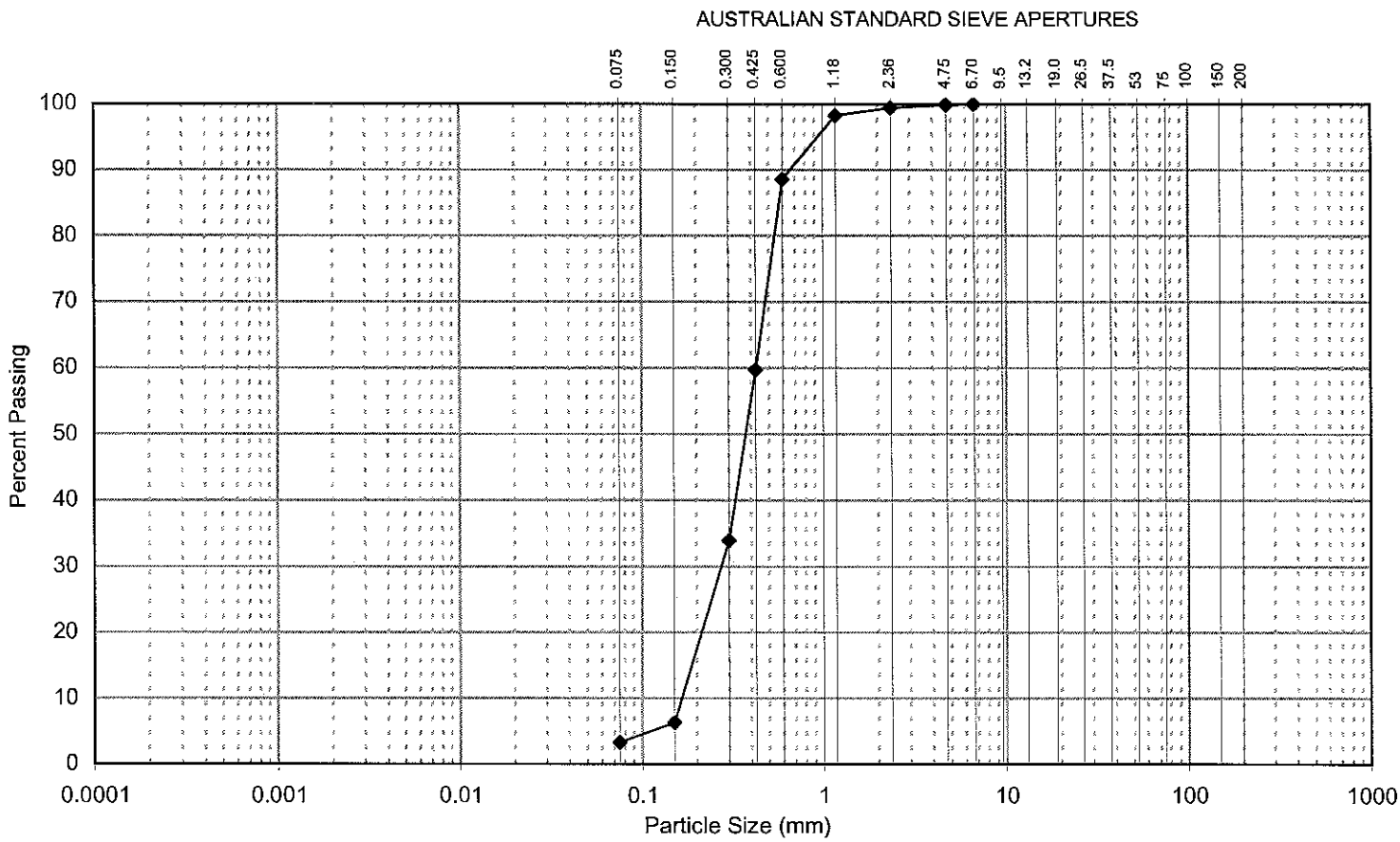
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004M
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 203	**Date of Test:**	6/01/2005
Depth / Layer :	12.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Dark brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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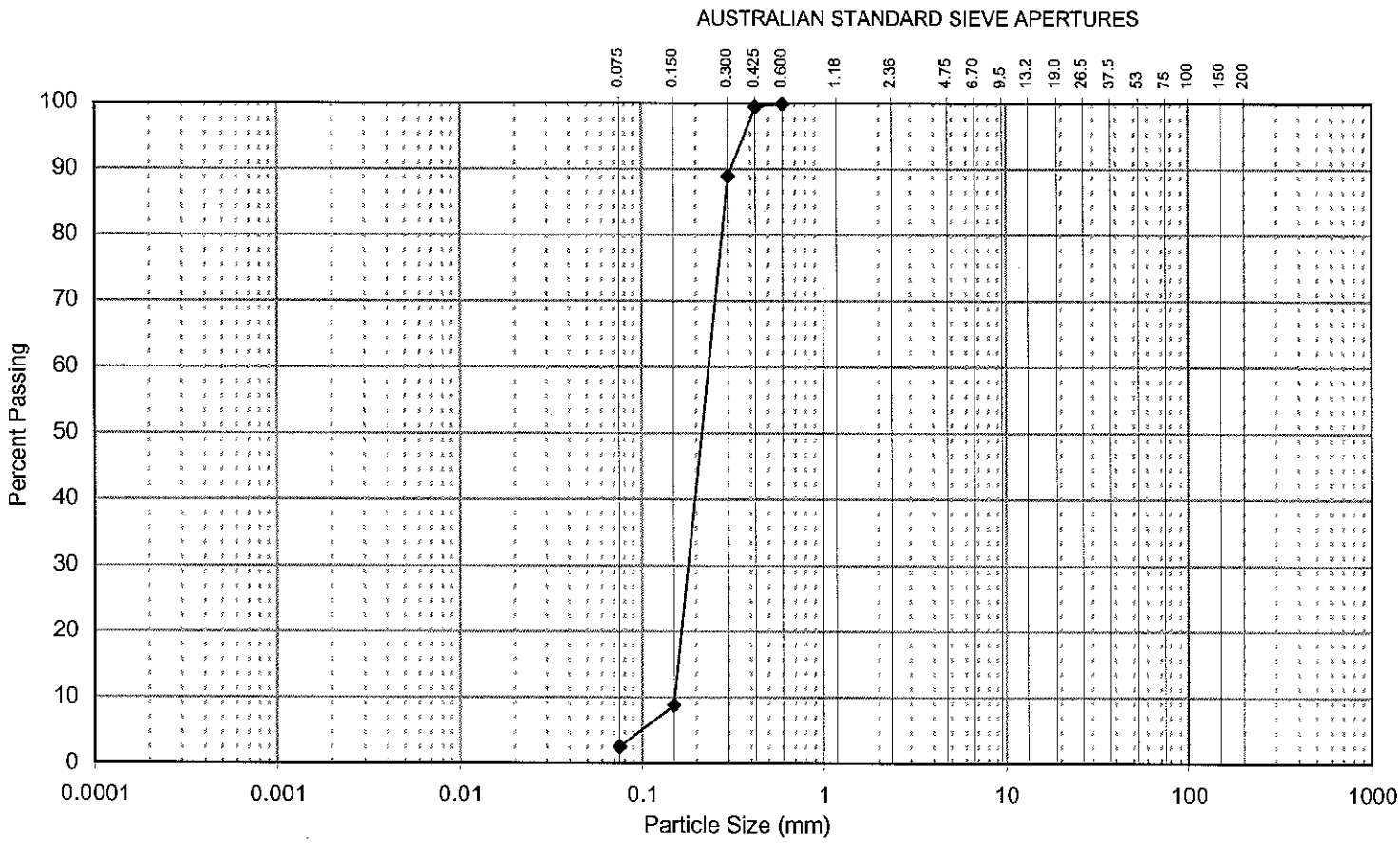
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004N
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 204	**Date of Test:**	6/01/2005
Depth / Layer :	0.5m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Yellow brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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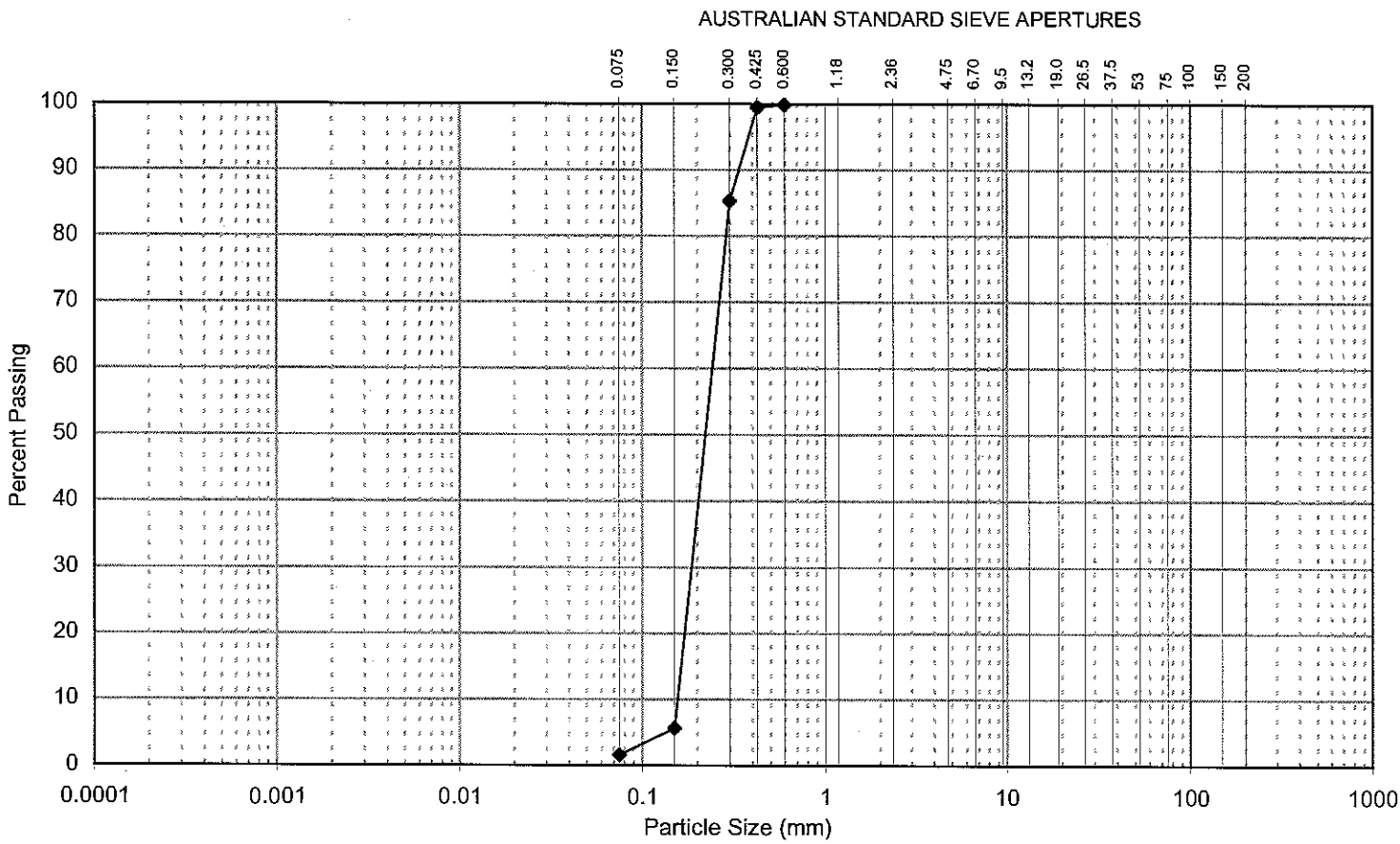
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
PO Box 486
Unanderra NSW 2526
Australia

Unit 1, 1 Luso Drive
Unanderra NSW 2526
Phone (02) 4271 1836
Fax: (02) 4271 1897
wollongong@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004O
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 204	**Date of Test:**	6/01/2005
Depth / Layer :	2.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: Yellow brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA Accredited Laboratory No 11183
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full

Approved Signatory:

Tested:	PB
Checked:	DE

David Evans
Laboratory Manager

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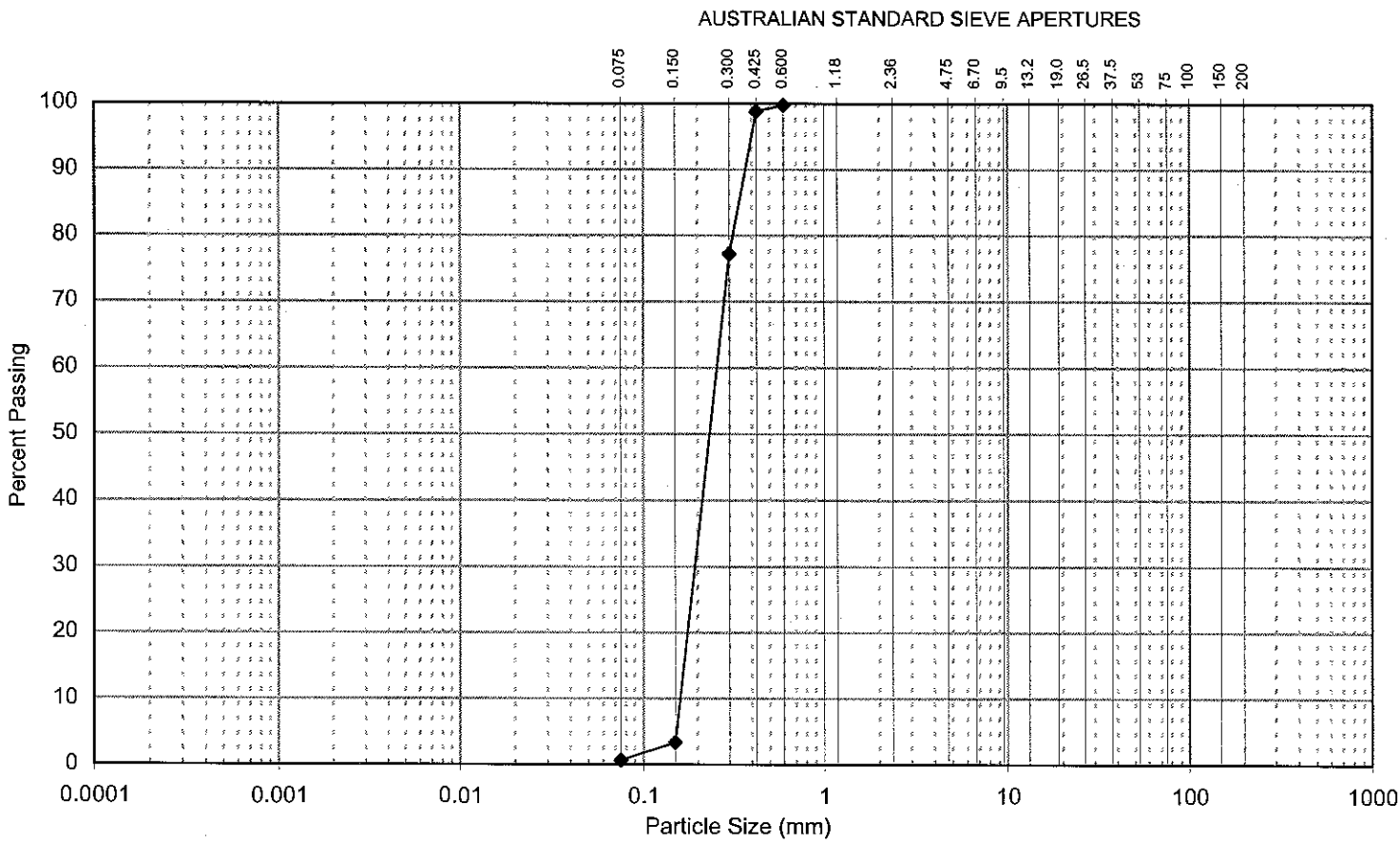
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004P
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 204	**Date of Test:**	6/01/2005
Depth / Layer :	4.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: Yellow sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

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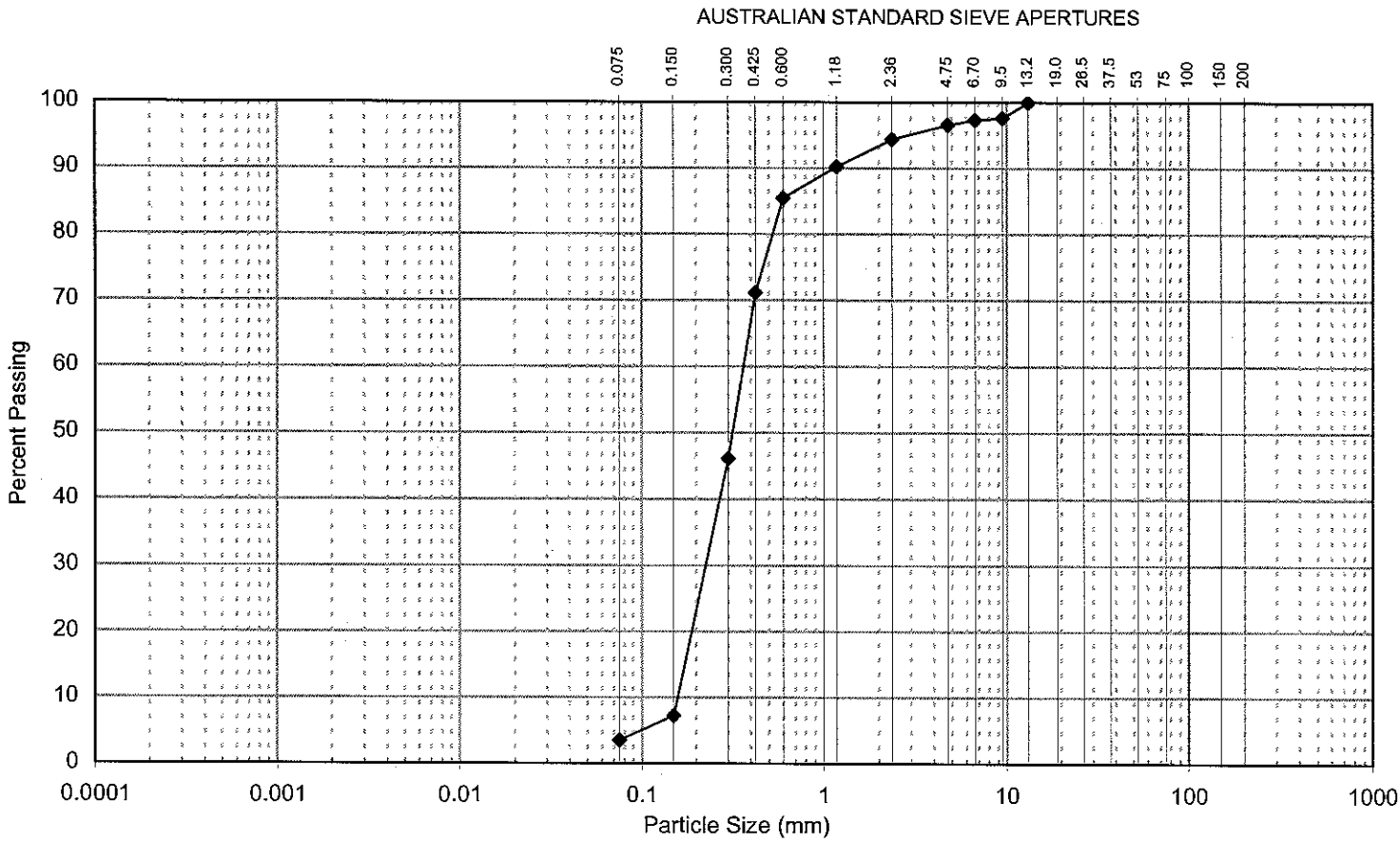
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004Q
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 204	**Date of Test:**	6/01/2005
Depth / Layer :	7.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Brown gravelly sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA Accredited Laboratory No 11183
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Approved Signatory:

Tested:	PB
Checked:	DE

David Evans
Laboratory Manager

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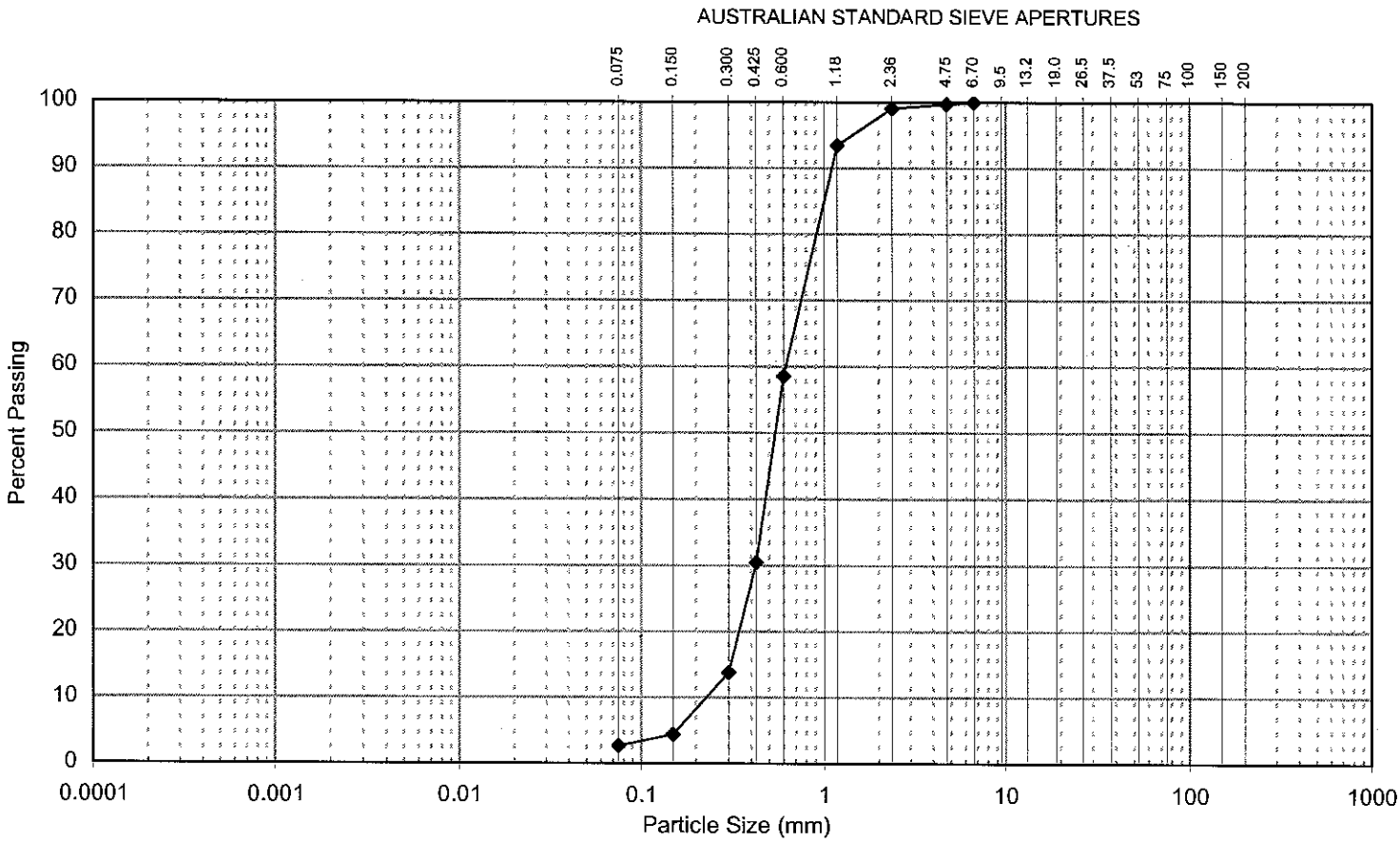
RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	CLEARY BROS (BOMBO) PTY LTD	**Project No. :**	37673
		Report No. :	UL05-004R
Project :	Proposed Northern Extension	**Report Date :**	11/01/2005
Location :	Gerroa Sand Quarry, Gerroa	**Date Sampled:**	20/12/2004
Test Location :	Bore 204	**Date of Test:**	6/01/2005
Depth / Layer :	12.0m	**Page:**	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60	

Description: Dark brown sand

Test Method(s): AS 1289.3.6.1-1995, 3.6.2-1995, 3.6.3-1995

Sampling Method(s): AS 1289.1.2.1-1998, AS 1289.1.1-2001

Method of Dispersion:

Remarks:

NATA Accredited Laboratory No 11183
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Approved Signatory:

Tested:	PB
Checked:	DE

David Evans
Laboratory Manager

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newcastle@douglaspartners.com.au

RESULTS OF PARTICLE DENSITY & WATER ABSORPTION (FINE)

Client: **Cleary Bros (Bombo) Pty Ltd**

Project: Proposed Northern Extension

Location: Gerroa Sand Quarry, Gerroa

Project No: 37673
Report No: N05-018
Report Date: 3/2/2005

Date Sampled: 20-23/12/2004
Date of Test: 20/1/2005
Page: 1 of 1

Sample Details		Bore 202 - 1.0m (Sand)	Bore 202 - 6.0m (Sand)	Bore 203 - 3.0m (Sand)
Apparent Particle Density	t/m^3	2.37	2.34	2.35
Particle Density on Dry Basis	t/m^3	2.32	2.32	2.33
Particle Density on Saturated Surface Dry Basis	t/m^3	2.34	2.33	2.34
Water Absorption	%	1.0	0.4	0.6

Test Method(s): AS1141.5.1 - 2000
Sampling Method(s): AS1141.3.1 - 1996
Remarks:

NATA Accredited Laboratory
Number: 1670
NATA endorsed test report. This document shall not be reproduced, except in full.

Approved Signatory:

Tested: AW/JP
Checked: DM

D Millard
Laboratory Manager

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Geotechnics · Environment · Groundwater

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newcastle@douglaspartners.com.au

RESULTS OF PARTICLE DENSITY & WATER ABSORPTION (FINE)

Client:	**Cleary Bros (Bombo) Pty Ltd**	**Project No:**	37673
		Report No:	N05-018a
Project:	Proposed Northern Extension	**Report Date:**	3/2/2005
		Date Sampled:	20-23/12/2004
Location:	Gerroa Sand Quarry, Gerroa	**Date of Test:**	20/1/2005
		Page:	1 of 1

Sample Details		Bore 203 - 11.0m (Sand)	Bore 204 3.0-5.0m (Sand)	
Apparent Particle Density	t/m^3	2.37	2.38	
Particle Density on Dry Basis	t/m^3	2.32	2.36	
Particle Density on Saturated Surface Dry Basis	t/m^3	2.34	2.37	
Water Absorption	%	1.0	0.3	

Test Method(s): AS1141.5.1 - 2000
Sampling Method(s): AS1141.3.1 - 1996
Remarks:

NATA Accredited Laboratory Number: 1670
NATA endorsed test report. This document shall not be reproduced, except in full.

Approved Signatory:

Tested: AW/JP
Checked: DM

D Millard
Laboratory Manager

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RESULTS OF ORGANIC IMPURITIES OTHER THAN SUGAR

Client:	**Cleary Bros (Bombo) Pty Ltd**	**Project No:**	37673
		Report No:	N05-018b
Project:	Proposed Northern Extension	**Report Date:**	3/2/2005
		Date Sampled:	20-23/12/2004
Location:	Gerroa Sand Quarry, Gerroa	**Date of Test:**	20/1/2005
		Page:	1 of 1

Sample Details:	Bore 201 (1.5m)	Bore 201 (6.0m)	Bore 204 (8.0m)
Result:	FAIL	PASS	PASS

Test Method(s): AS 1141.34 - 1997
Sampling Method(s): AS1141.3.1-1996
Remarks:

NATA Accredited Laboratory
Number: 1670
NATA endorsed test report. This document shall not be reproduced, except in full.

Approved Signatory:

Tested: AW
Checked: DM

D Millard
Laboratory Manager

APPENDIX C
Results of Previous Laboratory Physical Testing

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
Incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977)

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB201 3.0 - 5.0m	
6.7mm Sieve	100
4.75mm Sieve	98
2.36mm Sieve	97
1.18mm Sieve	95
600 µm Sieve	77
425 µm Sieve	54
300 µm Sieve	38
150 µm Sieve	12
75 µm Sieve	6
SHELL ANALYSIS (Sieve Fraction)	% SHELL*
-4.75mm to +1.18mm	15.8
-1.18mm to +75 µm	8.2

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorised Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

COFFEY

borehole no CB201
sheet of

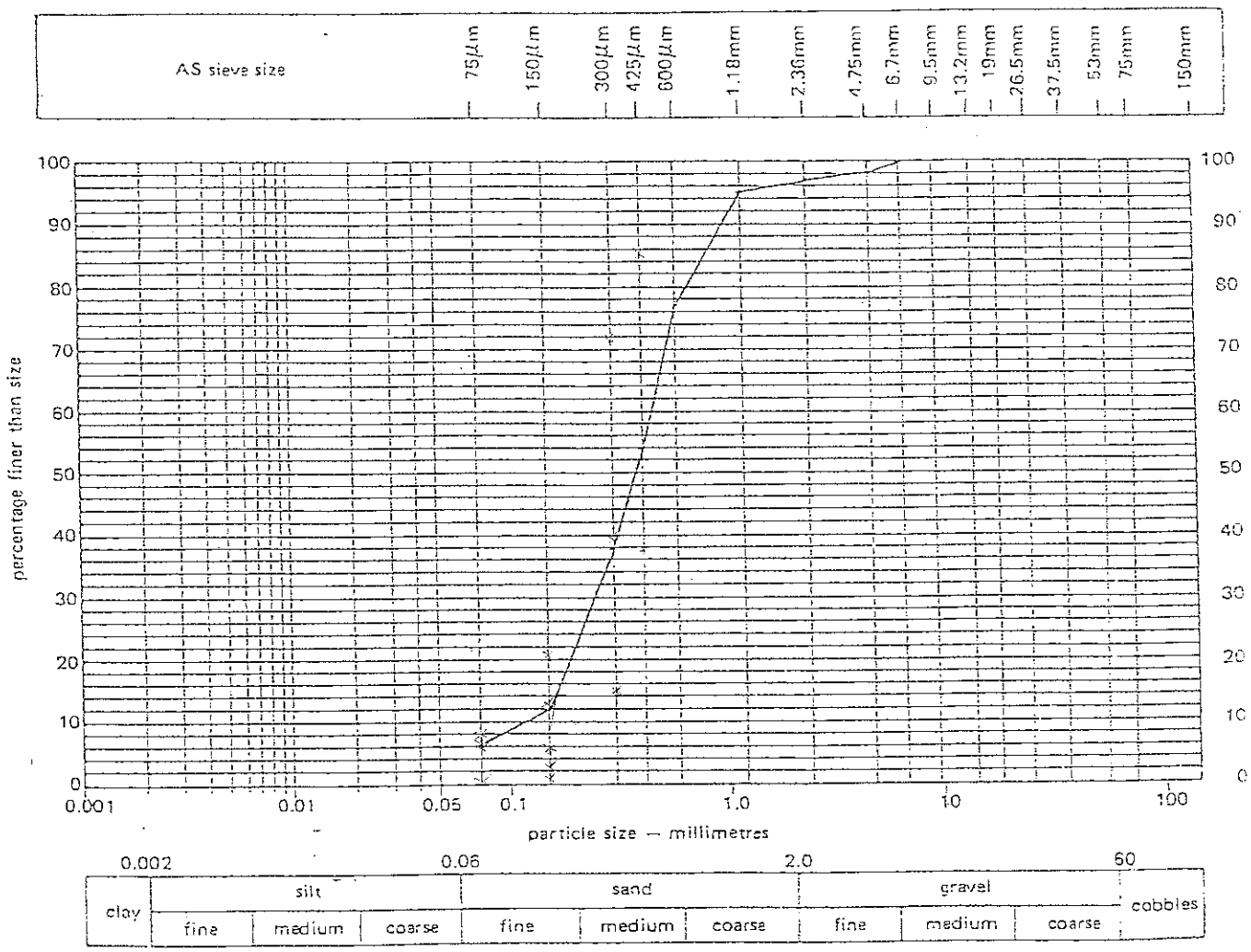
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

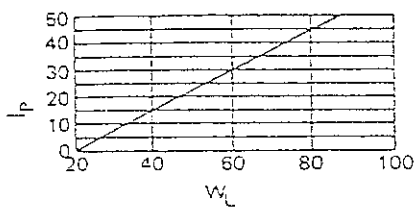
job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

sample identification 201
test procedure AS 1289 C6.1 (1977)

depth 3.0 - 5.0m



liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SW) SAND, fine to coarse grained, light grey, some fines, trace of fine gravel.

Authorised Signature A.R. Harley

COFFEY

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
Incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977)

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB201 4.9 - 5.4m	
26.5mm Sieve	100
19.0mm Sieve	98
13.2mm Sieve	96
9.5mm Sieve	95
6.7mm Sieve	94
4.75mm Sieve	94
2.36mm Sieve	92
1.18mm Sieve	88
600 µm Sieve	76
425 µm Sieve	59
300 µm Sieve	43
150 µm Sieve	13
75 µm Sieve	5
SHELL ANALYSIS (Sieve Fraction)	% SHELL*
-4.75mm to +1.18mm	10.2
-1.18mm to +75 µm	6.2

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorised Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

COFFEY

borehole no CB201
sheet: of

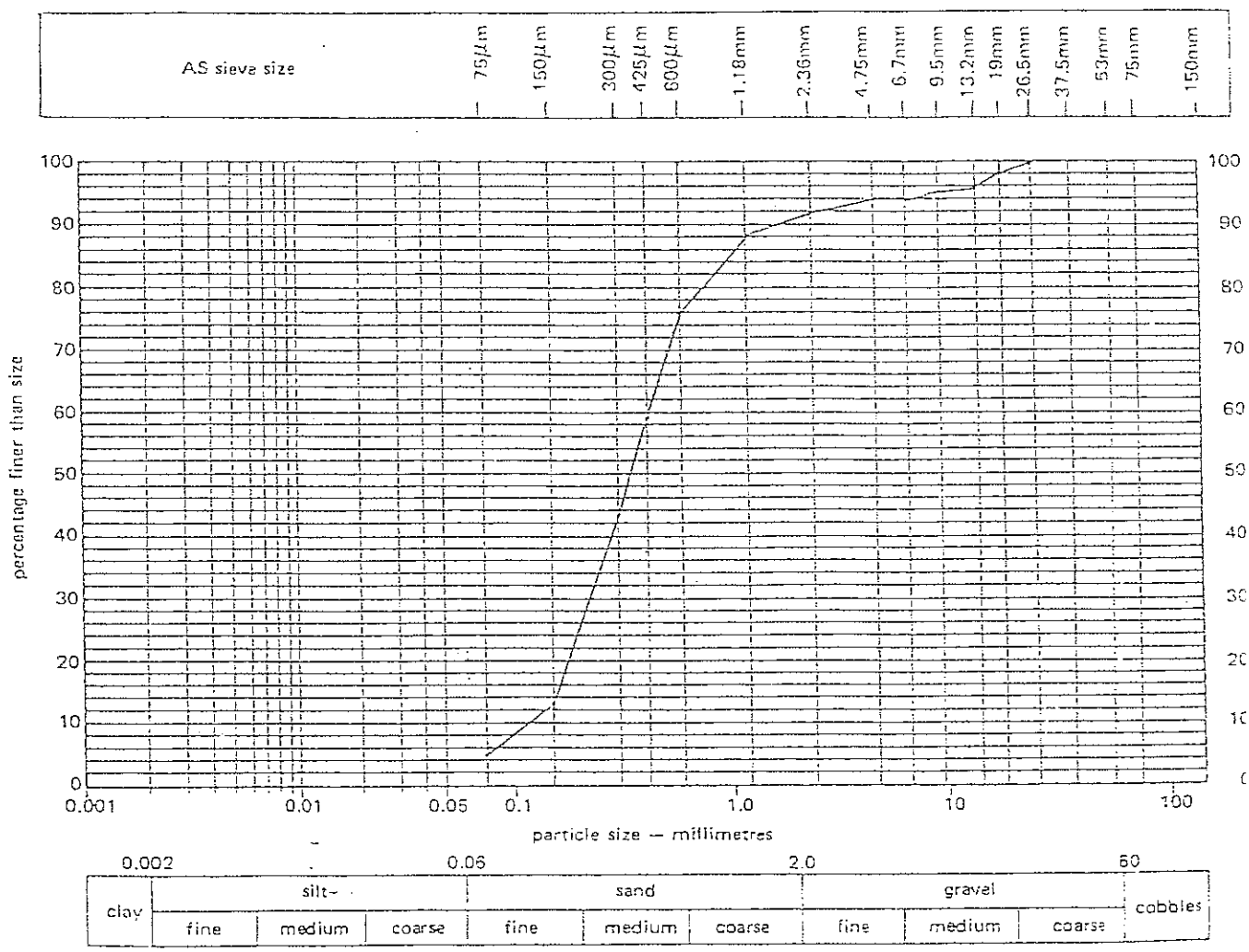
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

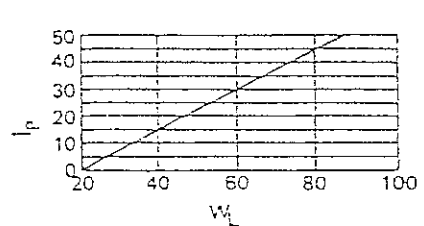
sample identification 201
test procedure AS 1289 C6.1 (1977)

depth 4.9 – 5.4m



AS–1289

liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SW) SAND, fine to coarse grained, light grey, some fine to medium grained gravel, trace of fines.

Authorised Signature

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977).

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB204 0 - 1.0m	
1.18mm Sieve	100
600 µm Sieve	98
425 µm Sieve	93
300 µm Sieve	86
150 µm Sieve	17
75 µm Sieve	12
SHELL ANALYSIS (Sieve Fraction)	% SHELL*
-4.75mm to +1.18mm	82.1
-1.18mm to +75 µm	7.5

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorised Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

COFFEY

borehole no CB204
sheet of

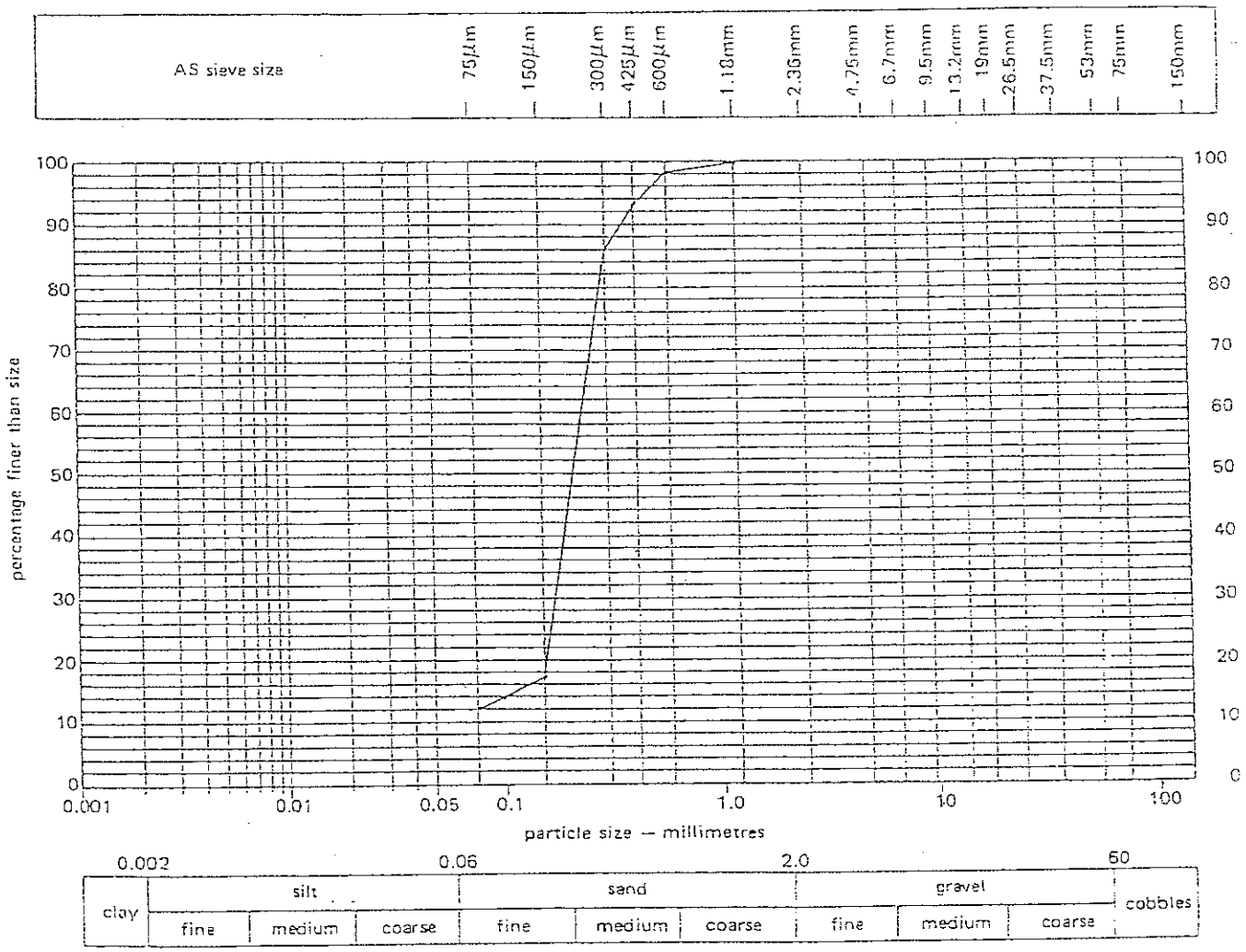
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

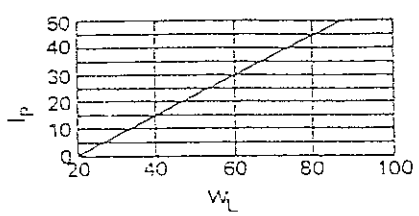
sample identification 204
test procedure AS 1289 C6.1 (1977)

depth 0.0 - 1.0m



AS—1289

liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SP) SAND, fine to medium grained, pale grey, some fines.

Authorised Signature

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
Incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977)

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB204 2.0 - 5.0m	
6.7mm Sieve	100
4.75mm Sieve	98
2.36mm Sieve	97
1.18mm Sieve	91
600 µm Sieve	60
425 µm Sieve	34
300 µm Sieve	19
150 µm Sieve	6
75 µm Sieve	4
SHELL ANALYSIS (Sieve Fraction)	% SHELL*
-4.75mm to +1.18mm	1.0
-1.18mm to +75 µm	2.6

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorised Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

COFFEY

borehole no CB204
sheet of

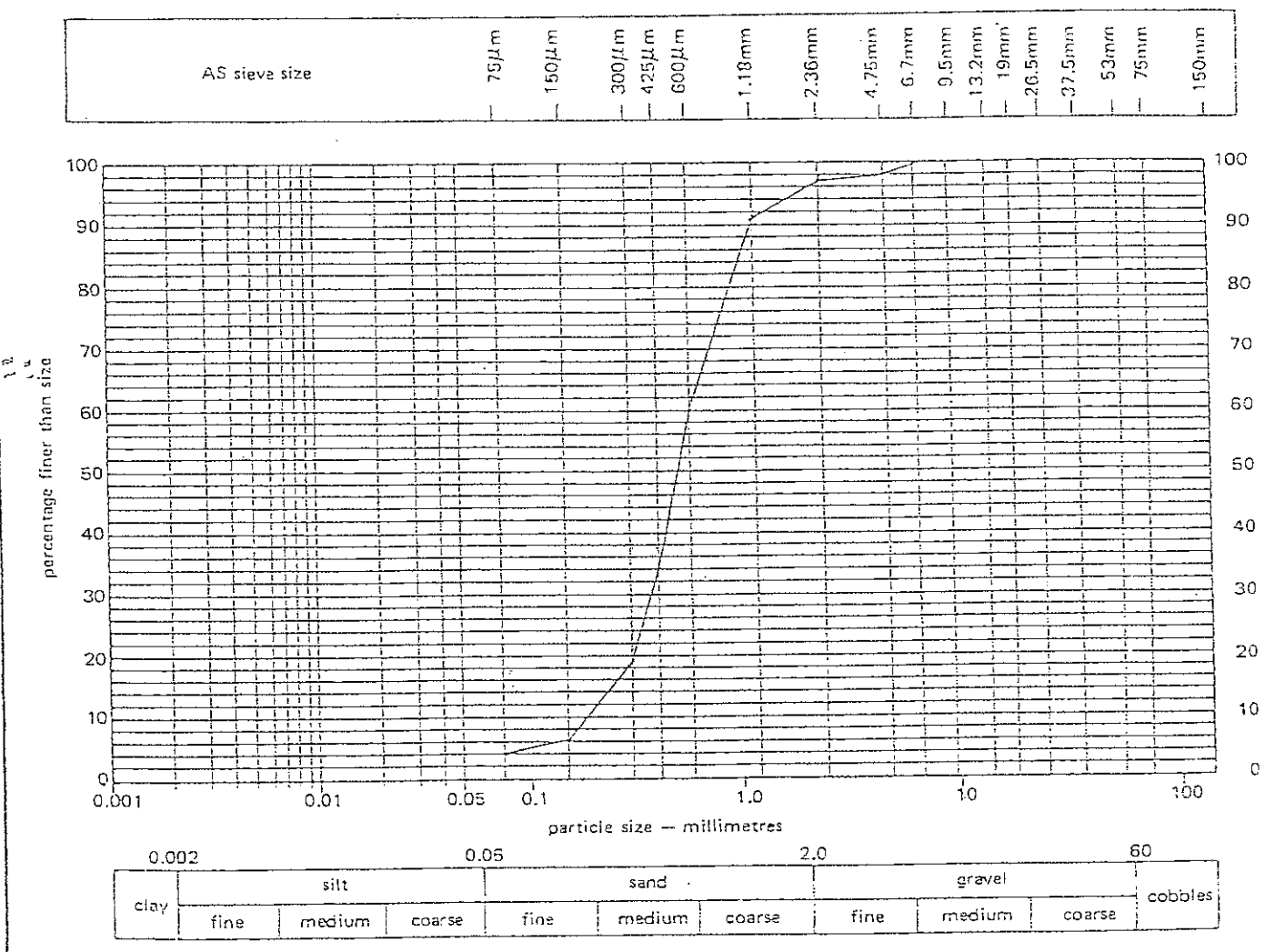
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

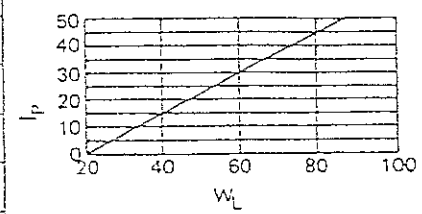
sample identification 204
test procedure AS 1289 C6.1 (1977)

depth 2.0 - 5.0m



AS-1289

liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SP) SAND, fine to coarse grained, grey, trace of fines, trace of fine gravel.

Authorised Signature

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
Incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977)

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB206 6.0 - 8.0m	
6.7mm Sieve	100
4.75mm Sieve	96
2.36mm Sieve	92
1.18mm Sieve	90
600 µm Sieve	85
425 µm Sieve	76
300 µm Sieve	63
150 µm Sieve	19
75 µm Sieve	10
SHELL ANALYSIS (Sieve Fraction)	% SHELL*
-4.75mm to +1.18mm	34.9
-1.18mm to +75 um	20.3

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorised Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

borehole no CB206
sheet of

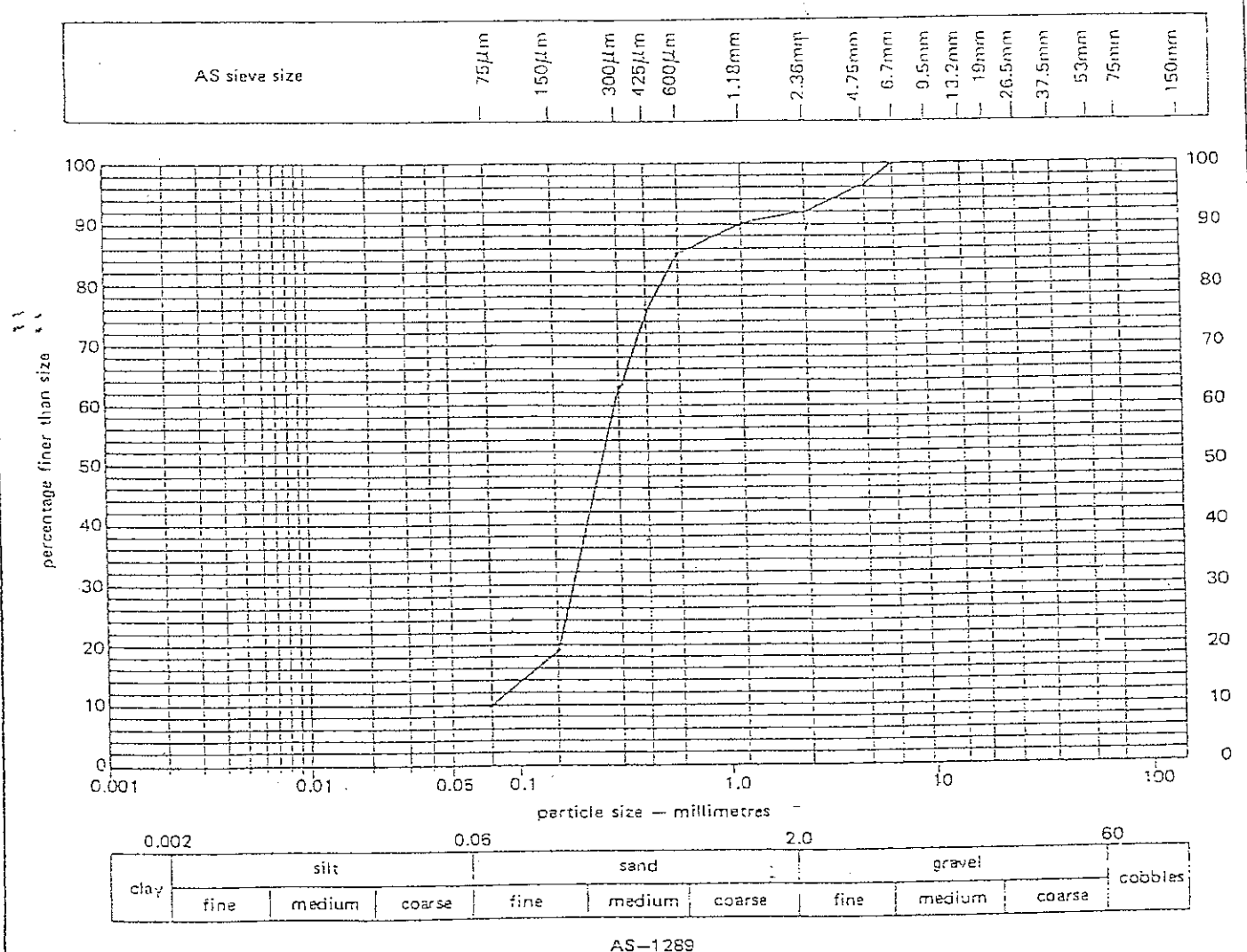
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

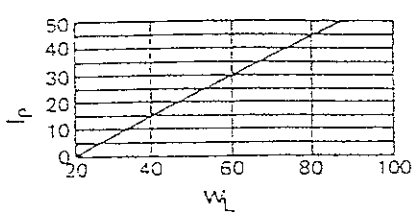
sample identification 206
test procedure AS 1289 C6.1 (1977)

depth 6.0 - 8.0m



AS—1289

liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SP) SAND, fine to coarse grained, yellow, some fines, some fine to medium gravel.

Authorised Signature

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
Incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977)

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB206 8.0 - 10.0m	
9.5mm Sieve	100
6.7mm Sieve	99
4.75mm Sieve	97
2.36mm Sieve	94
1.18mm Sieve	88
600 µm Sieve	73
425 µm Sieve	58
300 µm Sieve	44
150 µm Sieve	10
75 µm Sieve	6
SHELL ANALYSIS (Sieve Fractions)	% SHELL*
-4.75mm to +1.18mm	20.3
-1.18mm to +75 µm	6.3

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorized Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

borehole no CB206
sheet of

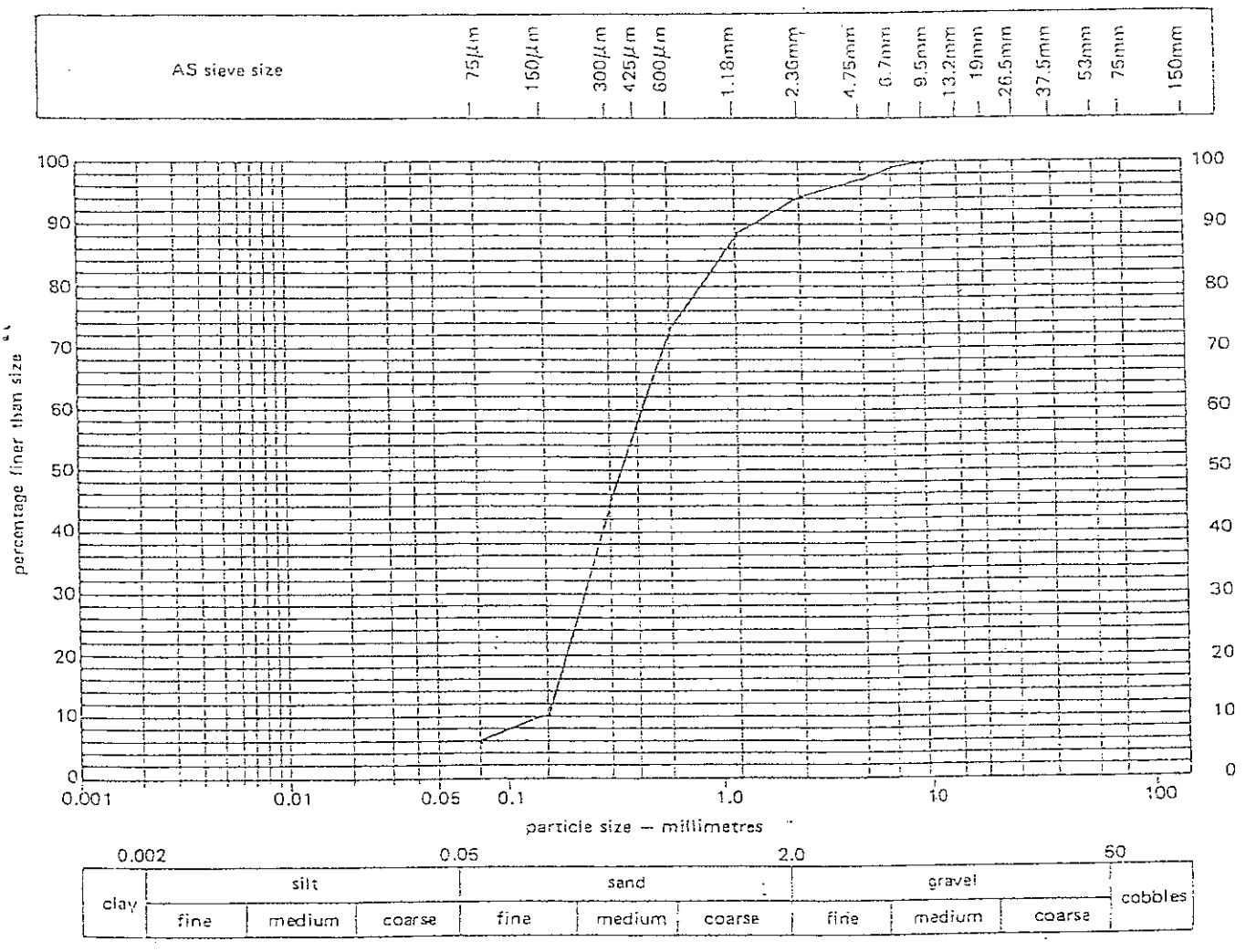
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

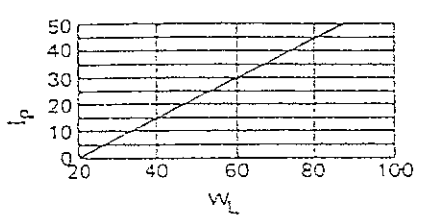
sample identification 206
test procedure AS 1289 C6.1 (1977)

depth 8.0 - 10.0m



AS-1289

liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SW) SAND, fine to coarse grained, pale yellow, some fines, some fine gravel.

Authorised Signature

Coffey Partners International Pty Ltd

Consulting Engineers
in the geotechnical sciences
Incorporated in NSW

test results

Laboratory: Wollongong

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

date: 26-7-90 job no: SC568/1

test procedure: AS 1289 C6.1 (1977)

SAMPLE NUMBER	DATE RECEIVED: 20-7-90 TEST RESULT
CB206 10.0 - 13.0m	
2.36mm Sieve	100
1.18mm Sieve	99
600 µm Sieve	84
425 µm Sieve	61
300 µm Sieve	41
150 µm Sieve	8
75 µm Sieve	3
SHELL ANALYSIS (Sieve Fraction)	% SHELL*
-4.75mm to +1.18mm	41.2
-1.18mm to +75µm	1.6

NOTE:

1. Shell content determined by non-standard method. For test method refer to covering letter of results.

* % Shell may include other soil particles susceptible to HCL acid attack.

\- Sample to small for shell analysis.

Authorised Signature

Coffey Partners International Pty Ltd
Incorporated in NSW

particle size distribution

COFFEY

borehole no CB206
sheet of

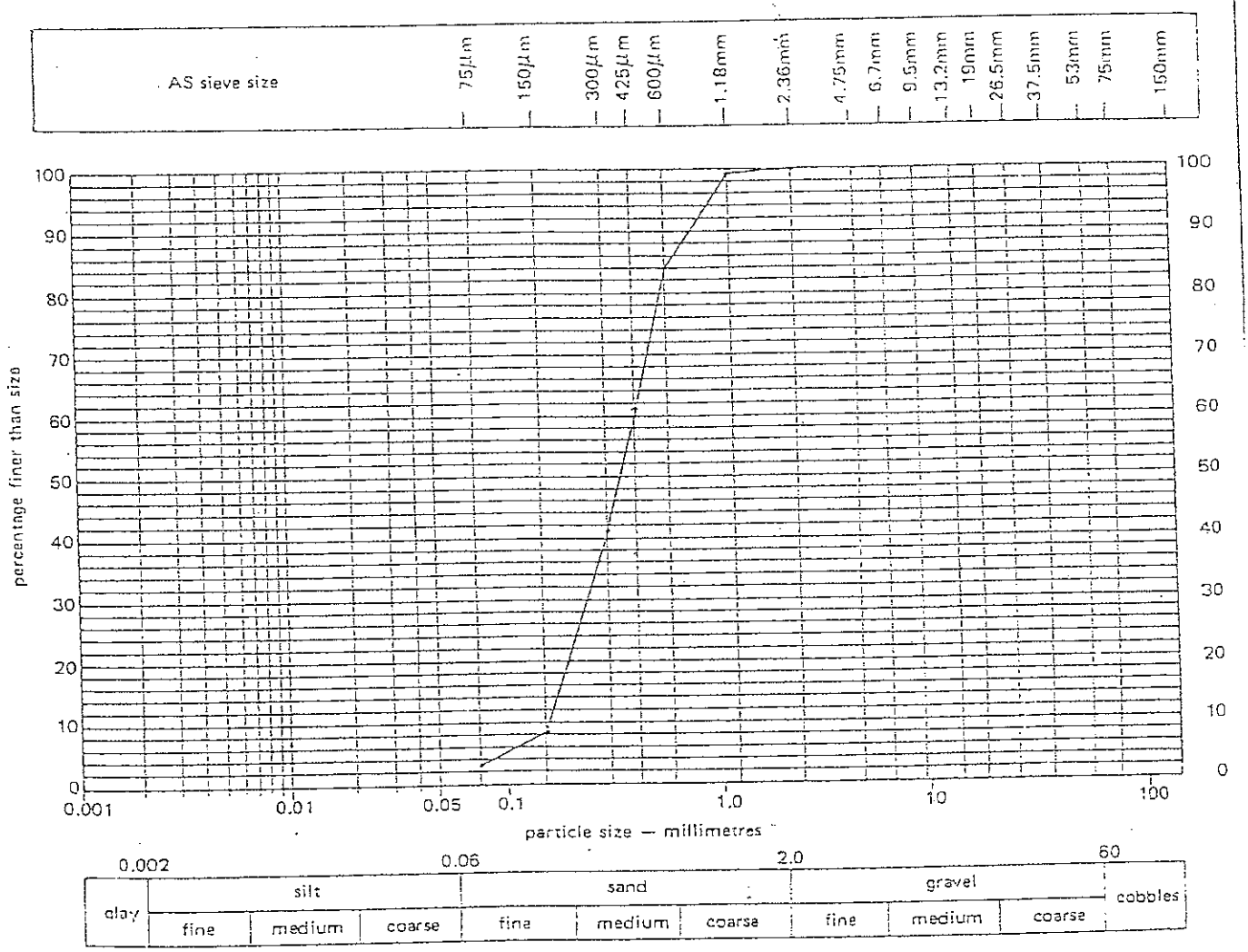
laboratory SOUTH COAST

client: Cleary Bros. (Bombo) Pty Ltd
project: Gerroa Sand Resource
location: Gerroa

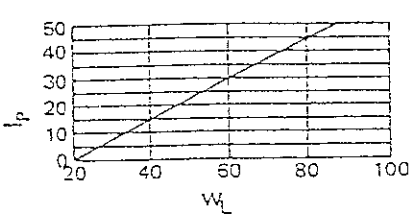
job no SC568/1
date 27-7-90
tested by J.D.
checked by S.T.

sample identification 206
test procedure AS 1289 C6.1 (1977)

depth 10.0 - 13.0m



liquid limit	%	—
plastic limit	%	—
plasticity index	%	—
linear shrinkage	%	—
particle density	t/m³	—
natural moisture	%	—



classification

(SW) SAND, fine to coarse grained, grey brown, some fines.

Authorised Signature

TEST METHOD - SHELL CONTENT OF SAMPLE

Samples received were oven dried overnight to a constant water content and dry sieved to separate soil fractions. The sieved fractions were then spilt down to a manageable sample size for the test.

The samples were weighed and the mass recorded. Hydrochloric acid was then added to the sample until all chemical reaction was observed to have ceased. Following acid treatment the samples were washed with tap water on a 75 um sieve to dilute the hydrochloric acid.

Samples were again oven dried and allowed to cool then reweighed. The difference in mass prior to, and after the addition of hydrochloric acid was recorded as a percentage of original mass of the sample, as follows:

$$\% \text{ Shell} = \frac{(M_A - M_B)}{M_A} \times 100$$

% Shell = Percentage of shells in sample

M_A = Mass of dried sample prior to adding acid

M_B = Mass of dried sample after adding sample

NOTE:

1. % Shell may also include other soil particles in the sample susceptible to acid attack.

TABLE A1.1

Laboratory Analyses of Sands from Gerroa Resource - Southern Extraction Area

Drill Hole No.	Depth of Hole (m)	Sample Depth (m)	% Passing 300 um	% Shell (>1.18 mm)	% Shell (<1.18 mm)	Unit
CB#201	6.5	3 to 5	38	-	8.2	2*
		4.9 to 5.4	43	10.2	6.2	2
CB#202	7.5	1 to 2	53	268	0.3	2
		2 to 3	24	8.4	0.4	2
		4 to 6	49	-	1.0	2
CB#203	7.0	0 to 2	66	-	0.7	2
		3 to 6	35	1.0	0.8	2
CB#204	5.5	0 to 1	86	-	7.5	1 - 2
		2 to 5	19	1.0	2.6	2
CB#205	10.5	0 to 6	76	-	0.5	1
		7 to 10	41	11.0	12.1	2
CB#206	14.0	6 to 8	63	34.9	20.3	2
		8 to 10	44	12.0	6.3	2
		10 to 13	41	1.0	1.6	2
* Disturbed						

27902APt1

Appendix 2

(No. of pages excluding cover page = 12)

Results from June 2000 Investigations

- Test Report Sheets for TP1, TP2 and TP3
- Carbonate Content

Network Geotechnics Pty Ltd

ACN 069 211 561
Unit 1/140 Industrial Road
Oak Flats NSW 2529
Telephone (02) 4257 4458
Facsimile (02) 4257 4463
Email wolnetgeo@bigpond.com

TEST REPORT SHEET

(Document No R18.0)

Client: Cleary Bros(Bombo) Pty Ltd	Job No: W2099/1
Project: Material Testing	
Location: Gerroa Quarry	Date: 13.7.00

SAMPLE DATA

Sample Number:	7		
Sample Location:	TP3 1.2m depth		
Date Sampled:	28.6.00		
Sampling Procedure:	AS1141.3.1		
Sample Description:	GERROA SAND		

TEST PROCEDURE		TEST RESULTS		
AS1141.11 (1996) (Washed)				
% Passing 6.7mm Sieve		-		
% Passing 4.75mm Sieve		100		
% Passing 2.36mm Sieve		100		
% Passing 1.18mm Sieve		99		
% Passing 600μm Sieve		80		
% Passing 425μm Sieve		49		
% Passing 300μm Sieve		22		
% Passing 150μm Sieve		10		
% Passing 75μm Sieve		8		
AS1141.34 (1997)				
Organic Impurities Other Than Sugar	Pass/Fail	Pass		
AS1289 2.1.1				
Moisture Content	%	17.0		

Comment:

NATA

THIS LABORATORY IS ACCREDITED BY THE NATIONAL ASSOCIATION OF TESTING AUTHORITIES AUSTRALIA. THE TESTING REPORTED HEREIN HAVE BEEN PERFORMED IN ACCORDANCE WITH ITS TERMS OF ACCREDITATION. THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL.
NATA ACCREDITED No. 1103

Approved Signature: 13/7/00

Network Geotechnics Pty Ltd

ACN 069 211 5
Unit 1/140 Industrial Roa
Oak Flats NSW 252
Telephone (02) 4257 445
Facsimile (02) 4257 445
Email wolnetgeo@Bigpond.co

TEST REPORT SHEET

(Document No R18.0)

Client: Cleary Bros(Bombo) Pty Ltd	Job No: W2099/1
Project: Material Testing	
Location: Gerroa Quarry	Date: 13.7.00

SAMPLE DATA

Sample Number:	8		
Sample Location:	TP3 4m depth		
Date Sampled:	28.6.00		
Sampling Procedure:	AS1141.3.1		
Sample Description:	GERROA SAND		

TEST PROCEDURE		TEST RESULTS		
AS1141.11 (1996) (Washed)				
% Passing 6.7mm Sieve		100		
% Passing 4.75mm Sieve		100		
% Passing 2.36mm Sieve		100		
% Passing 1.18mm Sieve		99		
% Passing 600µm Sieve		89		
% Passing 425µm Sieve		68		
% Passing 300µm Sieve		40		
% Passing 150µm Sieve		13		
% Passing 75µm Sieve		7		
AS1141.34 (1997)				
Organic Impurities Other Than Sugar	Pass/Fail	Fail		
AS1289 2.1.1				
Moisture Content	%	19.9		

Comment:

Approved Signature 13/7/00

Network Geotechnics Pty Ltd

ACN 05[illegible]
Unit 1/140 Industrial Road
Oak Flats NSW 2529
Telephone (02) 4257 4455
Facsimile (02) 4257 4463
Email wolnetgeo@Bigpond.com

TEST REPORT SHEET

(Document No R18 01

Client: Cleary Bros(Bombo) Pty Ltd	Job No: W2099/1
Project: Material Testing	
Location: Gerroa Quarry	Date: 13.7.00

SAMPLE DATA

Sample Number:	9		
Sample Location:	TP3 6m depth		
Date Sampled:	28.6.00		
Sampling Procedure:	AS1141.3.1		
Sample Description:	GERROA SAND		

TEST PROCEDURE		TEST RESULTS		
AS1141.11 (1996) (Washed)				
% Passing 6.7mm Sieve		100		
% Passing 4.75mm Sieve		100		
% Passing 2.36mm Sieve		100		
% Passing 1.18mm Sieve		99		
% Passing 600µm Sieve		76		
% Passing 425µm Sieve		35		
% Passing 300µm Sieve		12		
% Passing 150µm Sieve		5		
% Passing 75µm Sieve		2		
AS1141.34 (1997)				
Organic Impurities Other Than Sugar	Pass/Fail	Fail		
AS1289 2.1.1				
Moisture Content	%	21.3		

Comment:

Approved Signature 13/7/00

Network Geotechnics Pty Ltd

ACN 069 241 39
Unit 1/140 Industrial Road
Oak Flats NSW 2529
Telephone (02) 4257 4455
Facsimile (02) 4257 4461
Email wolnetgeo@Bigpond.com

TEST REPORT SHEET

(Document No R18.0

Client: Cleary Bros(Bombo) Pty Ltd	Job No: W2099/1
Project: Material Testing	
Location: Gerroa Quarry	Date: 13.7.00

SAMPLE DATA

Sample Number:	10		
Sample Location:	TP3 7.5m depth		
Date Sampled:	28.6.00		
Sampling Procedure:	AS1141.3.1		
Sample Description:	GERROA SAND		

TEST PROCEDURE		TEST RESULTS		
AS1141.11 (1996) (Washed)				
% Passing 6.7mm Sieve		-		
% Passing 4.75mm Sieve		100		
% Passing 2.36mm Sieve		100		
% Passing 1.18mm Sieve		100		
% Passing 600μm Sieve		89		
% Passing 425μm Sieve		64		
% Passing 300μm Sieve		33		
% Passing 150μm Sieve		10		
% Passing 75μm Sieve		5		
AS1141.34 (1997)				
Organic Impurities Other Than Sugar	Pass/Fail	Fail		
AS1289 2.1.1				
Moisture Content	%	20.0		

Comment:

Approved Signature. 13/7/00

CARBONATE CONTENT

(By acid digestion)

LAB No	SAMPLE SOURCE	DESCRIPTION	CARBONATE (%)
22873	#1	SAND	Not Detectable*
22874	#2	SAND	Not Detectable
22975	#3	SAND	Not Detectable
22876	#4	SAND	Not Detectable
22877	#5	SAND	Not Detectable
22878	#6	SAND	Not Detectable
22879	#7	SAND	Not Detectable
22880	#8	SAND	Not Detectable
22881	#9	SAND	Not Detectable
22882	#10	SAND	Not Detectable
22883	#11	SAND	Not Detectable

Date Tested: 17.07.2000

Sampled By: CLIENT

Signed:

TEST METHODS

APHA:

*: below limits of this method: Less than 0.2%

PROJECT
NETWORK GEOTECHNICS
JobL W2099/1

AUSTRALIAN SOIL TESTING PTY LTD
19 BERMILL ST, ROCKDALE 2216
Phone 9597 5599 Fax 9597 3442

APPENDIX D
Results of Chemical Testing

Douglas Partners
Geotechnics · Environment · Groundwater

RESULTS OF ACID SULFATE SCREENING TESTS

Client: Cleary Bros (Bombo) Pty Ltd
Project: Proposed Northern Extension
Project Location: Gerroa Sand Quarry, Gerroa

Project No: 37673
pH Meter: ☐ TPS with Ionode IJ46/WP80 pH/Temp. Electrode
☑ _____
Calibration Buffer: ☑ pH4 ☑ pH7 ☐ pH10

Sample Location	Depth (m)	pH_F (in distilled water)	pH_{FOX} (oxidised in H_sO_s)			Strength of Reaction	Soil Description
		Date:23/12/04 Time:	Date:23/12/04 Time:	Date: Time:	Date: Time:	(1,2,3,4)* F **	
BH 201	A/S 0.5	6.2	5.9			1	Silty Sand
BH 201	A/S 1.0	6.3	6.2			1	Silty Sand
BH 201	STP 1.0	6.5	6.2			1	Silty Sand
BH 201	A/S 1.5	6.5	6.2			1	Silty Sand
BH 201	SPT2.0	6.6	5.8			1	Silty Sand
BH 201	SPT 3.0	6.7	6.3			1	Sand
BH 201	SPT 4.0	7.0	6.4			1	Sand
BH 201	SPT5.0	7.9	7.7			1	Sand
BH 201	SPT 6.0	7.8	7.9			1	Sand
BH 201	SPT 7.0	7.9	8.2			1	Sand
BH 201	SPT 8.0	8.2	7.7			1	Sand
BH 201	SPT 9.0	8.4	7.4			1	Gravely Sand
BH 201	SPT 10.0	8.1	5.9			1	Sand
BH 201	SPT 11.0	8.1	5.6			1	Sand
BH 201	SPT 12.0	8.0	4.7			1	Sand

Legend: * *1 denotes no or slight effervescence*
2 denotes moderate effervescence
3 denotes vigorous effervescence
4 denotes "volcano" ie. very vigorous effervescence, gas evolution and heat
** F after reaction number indicates a bubbling/frothy reaction (organics

Operator: LMcK/AC
Date: *23 Dec. 04*

Douglas Partners
Geotechnics · Environment · Groundwater

RESULTS OF ACID SULFATE SCREENING TESTS

Client: Cleary Bros (Bombo) Pty Ltd
Project: Proposed Northern Extension
Project Location: Gerroa Sand Quarry, Gerroa

Project No: 37673
pH Meter: ☐ TPS with Ionode IJ46/WP80 pH/Temp. Electrode
☑ _____
Calibration Buffer: ☑ pH4 ☑ pH7 ☐ pH10

Sample Location	Depth (m)	pH_F (in distilled water)	pH_{FOX} (oxidised in H_sO_s)			Strength of Reaction	Soil Description
		Date:22/12/04 Time:	Date:22/12/04 Time:	Date: Time:	Date: Time:	(1,2,3,4)* F **	
BH 201	SPT 13.0	7.9	2.5			2	Clayey Sand
BH 202	A/S 0.5	8.3	4.8			1	Silty Sand
BH 202	A/S 1.0	8.3	5.8			1	Silty Sand
BH 202	SPT 1.0	7.9	5.6			1	Silty Sand
BH 202	A/S 1.5	8.0	5.8			1	Silty Sand
BH 202	SPT 2.0	6.8	7.0			1	Silty Sand
BH 202	SPT 3.0	6.9	6.8			1	Silty Sand
BH 202	SPT 4.0	7.4	6.8			1	Silty Sand
BH 202	SPT 5.0	8.2	7.4			1	Silty Sand
BH 202	SPT 6.0	7.9	7.4			1	Sand
BH 202	SPT 7.0	7.7	7.6			1	Sand
BH 202	SPT 9.0	7.7	7.7			1	Silty Sand
BH 202	SPT 10.0	7.7	5.6			1	Clayey Sand
BH 202	SPT 11.0	7.7	4.8			1/2	Sand
BH 202	SPT 12.0	7.7	5.9			1	Sand

Legend: * *1 denotes no or slight effervescence*
2 denotes moderate effervescence
3 denotes vigorous effervescence
4 denotes "volcano" ie. very vigorous effervescence, gas evolution and heat
** F after reaction number indicates a bubbling/frothy reaction (organics

Operator: LMcK/AC
Date: *23 Dec. 04*

Douglas Partners
Geotechnics · Environment · Groundwater

RESULTS OF ACID SULFATE SCREENING TESTS

Client: Cleary Bros (Bombo) Pty Ltd
Project: Proposed Northern Extension
Project Location: Gerroa Sand Quarry, Gerroa

Project No: 37673
pH Meter: ☐ TPS with Ionode IJ46/WP80 pH/Temp. Electrode
☑ _____
Calibration Buffer: ☑ pH4, ☑ pH7, ☐ pH10

Sample Location	Depth (m)	pH_F (in distilled water)	pH_{FOX} (oxidised in H_sO_s)			Strength of Reaction	Soil Description
		Date:22/12/04	Date:22/12/04	Date:	Date:	(1,2,3,4)*	
		Time:	Time:	Time:	Time:	F **	
BH 202	SPT 13.0	6.6	6.2			1	Sand
BH 202	SPT 14.0	6.8	6.2			1	Sand
BH 202	SPT 15.0	7.0	6.2			1	Sand
BH 203	0.5	7.5	6.0			1	Sand
BH 203	1.0	7.2	6.1			1	Sand
BH 203	1.5	7.3	6.0			1	Sand
BH 203	2.0	7.3	6.4			1	Sand
BH 203	3.0	7.7	6.5			1	Sand
BH 203	4.0	7.4	6.5			1	Sand
BH 203	5.0	7.4	6.5			1	Sand
BH 203	6.0	7.4	6.8			1	Sand
BH 203	7.0	7.9	7.4			1	Sand
BH 203	8.0	7.7	7.5			1	Sand with Shells
BH 203	9.0	7.5	6.8			1	Fine Gravely Sand

Legend: * *1 denotes no or slight effervescence*
2 denotes moderate effervescence
3 denotes vigorous effervescence
4 denotes "volcano" ie. very vigorous effervescence, gas evolution and heat
** F after reaction number indicates a bubbling/frothy reaction (organics

Operator: LMcK/AC
Date: *23 Dec. 04*

Douglas Partners
Geotechnics · Environment · Groundwater

RESULTS OF ACID SULFATE SCREENING TESTS

Client: Cleary Bros (Bombo) Pty Ltd
Project: Proposed Northern Extension
Project Location: Gerroa Sand Quarry, Gerroa

Project No: 37673
pH Meter: ☐ TPS with Ionode IJ46/WP80 pH/Temp. Electrode
☑ _____
Calibration Buffer: ☑ pH4 ☑ pH7 ☐ pH10

Sample Location	Depth (m)	pH_F (in distilled water)	pH_{FOX} (oxidised in H_sO_s)			Strength of Reaction	Soil Description
		Date:23/12/04	Date:23/12/04	Date:	Date:	(1,2,3,4)*	
		Time:	Time:	Time:	Time:	F **	
BH 203	10.0	7.4	7.1			1	Fine Gravely Sand
BH 203	11.0	7.6	7.5			1	Sand
BH 203	12.0	7.9	7.2			1	Sand
BH 203	13.0	7.9	7.2			1	Sand with Shells
BH 203	14.0	7.9	7.0			1	Sand
BH 203	15.0	7.9	6.9			1	Sand
BH 204	A/S 0.5	7.3	6.2			1	Silty Sand
BH 204	SPT 1.0	7.4	6.2			1	Silt
BH 204	A/S 1.0	7.4	6.5			1	Silty Sand
BH 204	A/S 1.5	7.4	6.2			1	Silty Sand
BH 204	SPT 2.0	7.4	6.1			1	Silty Sand
BH 204	SPT 3.0	7.3	6.1			1	Silty Sand
BH 204	SPT 4.0	7.2	6.1			1	Silty Sand
BH 204	SPT 5.0	7.9	7.9			1	Sand

Legend: * *1 denotes no or slight effervescence*
2 denotes moderate effervescence
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** F after reaction number indicates a bubbling/frothy reaction (organics

Operator: LMcK/AC
Date: *23 Dec. 04*

Douglas Partners
Geotechnics · Environment · Groundwater

RESULTS OF ACID SULFATE SCREENING TESTS

Client: Cleary Bros (Bombo) Pty Ltd
Project: Proposed Northern Extension
Project Location: Gerroa Sand Quarry, Gerroa

Project No: 37673
pH Meter: ☐ TPS with Ionode IJ46/WP80 pH/Temp. Electrode
☑ _____
Calibration Buffer: ☑ pH4, ☑ pH7, ☐ pH10

Sample Location	Depth (m)	pH_F (in distilled water)	pH_{FOX} (oxidised in H_sO_s)			Strength of Reaction	Soil Description
		Date:22/12/04 Time:	Date:22/12/04 Time:	Date: Time:	Date: Time:	(1,2,3,4)* F **	
BH 204	SPT 6.0	7.9	7.1			1	Silty Sand
BH 204	SPT 7.0	8.2	7.3			1	Sand
BH 204	SPT 8.0	8.2	7.7			1	Sand
BH 204	10.0	6.3	6.4			1	Sand with Shells
BH 204	11.0	6.2	6.4			1	Sand with Shells
BH 204	12.0	6.5	6.4			1	Sand with Shells
BH 204	13.0	6.6	6.5			1	Sand with Shells
BH 204	14.0	7.7	6.5			2	Clay
BH 204	15.0	7.8	6.5			3	Clay

Legend: * *1 denotes no or slight effervescence*
2 denotes moderate effervescence
3 denotes vigorous effervescence
4 denotes "volcano" ie. very vigorous effervescence, gas evolution and heat
** F after reaction number indicates a bubbling/frothy reaction (organics

Operator: LMcK/AC
Date: *23 Dec. 04*

14 January 2005 **TEST REPORT**

Douglas Partners Pty Ltd
1 / 1 Luso Drive
UNANDERRA
NSW 2526

Your Reference: 37673, Gerroa
Report Number: 34150

Attention: Arthur Castrissios

Dear Arthur
The following samples were received from you on the date indicated.

Samples:	Qty.	3 Soils
Date of Receipt of Samples:		07/01/05
Date of Receipt of Instructions:		07/01/05
Date Preliminary Report Faxed:		Not Issued

These samples were analysed in accordance with your written instructions.
A copy of the instructions is attached with the analytical report.

The results and associated quality control are contained in the following pages of this report. Unless otherwise stated, solid samples are expressed on a dry weight basis (moisture has been supplied for your information only), air and liquid samples as received.

Should you have any queries regarding this report please contact the undersigned.

Yours faithfully
SGS ENVIRONMENTAL SERVICES

Jacinta Hurst
Operations Manager

SGS Australia Pty Ltd
ABN 44 000 964 278
Environmental Services Botany Industrial Park Gate 3, Denison Street, Matraville 2036 NSW Australia
t +61 (0)2 9666 1426 f +61 (0)2 9666 1364 url www.sgs.com

Inorganics Our Reference: Your Reference Sample Type	UNITS ---------- ----------	34150-1 Bole 201/1 .5m soil	34150-2 Bole 201/ 3m soil	34150-3 Bole 203/ 4m soil
pH 1:5 soil:water	pH Units	6.2	6.3	6.7
Chloride, Cl* 1:5 soil:water	mg/kg	22	52	1.5
Sulphate, SO4* 1:5 soil:water	mg/kg	6.2	8.1	<2.0

Method ID	Methodology Summary
SEI-001	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
SEI-038	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 20th ED, 4110 -B.

QUALITY CONTROL Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Matrix Spike % Recovery Duplicate + %RPD
pH 1:5 soil:water	pH Units		SEI-001	[NT]	[NT]	[NT]	Batch	[NT]
Chloride, Cl* 1:5 soil: water	mg/kg	0.5	SEI-038	<0.50	[NT]	[NT]	Batch	106 || [N/T]
Sulphate, SO4* 1:5 soil :water	mg/kg	2	SEI-038	<2.0	[NT]	[NT]	Batch	106 || [N/T]

Result Codes

[INS]	:	Insufficient Sample for this test	[HBG]	:	Results not Reported due to High Background Interference
[NR]	:	Not Requested	*	:	Not part of NATA Accreditation
[NT]	:	Not tested	[N/A]	:	Not Applicable

Result Comments

Date Organics extraction commenced: N/A
NATA Corporate Accreditation No. 2562, Site No 4354
Note: Test results are not corrected for recovery (excluding Dioxins/Furans and PAH in XAD and PUF).

Quality Control Protocol

Reagent Blank: Sample free reagents carried through the preparation/extraction/digestion procedure and analysed at the beginning of every sample batch analysis. For larger projects, a reagent blank is prepared and analysed with every 20 samples.
Duplicate: A separate portion of a sample being analysed which is treated the same as the other samples in the batch. A duplicate is prepared at least every 20 samples.
Matrix Spike Duplicates: Sample replicates spiked with identical concentrations of target analyte(s). The spiking occurs during the sample preparation and prior to the extraction/digestion procedure. They are used to document the precision and bias of a method in a given sample matrix. Where there is not enough sample available to prepare a spiked sample, another known soil/sand or water (or Milli-Q water) may be used. A duplicate spiked sample is prepared at least every 20 samples.
Surrogate Spike: Added to all samples requiring analysis for organics (where relevant) prior to extraction. Used to determine the extraction efficiency. They are organic compounds which are similar to the target analyte(s) in chemical composition and behaviour in the analytical process, but which are not normally found in environmental samples.
Internal Standard: Added to all samples requiring analysis for organics (where relevant) after the extraction process; the compounds serve to give a standard of retention time and response, which is invariant from run-to-run with the instruments.
Control Standards: Prepared from a source independent of the calibration standards. At least one control standard is included in each run to confirm calibration validity.
Additional QC Samples: A calibration standard and blank are run after every 20 samples of an instrumental analysis run to assess analytical drift.

SPOCAS Profile

Test Type I sPOCAS
Order No 52429 Job No: 37673
Reference Proposed Northern Extension
Sample Name Pit 201/5m
Sample No. 86307
Date Received 05/01/2005 Total No Pages: 1 of 1
Client: Douglas Partners (Wollongong)
Chris Wing/Arthur Castrissois
PO Box 486
UNANDERRA NSW 2526

Quality Endorsed Company

Sydney Environmental and Soil Laboratory
Specialists in Soil Chemistry and Agronomy

Sydney Environmental and Soil Laboratory Pty Ltd
ABN 70 106 810 708
16 Chilvers Road
Thornleigh NSW 2120
Australia
Address Mail to
PO Box 357
Pennant Hills NSW 1715
Telephone:(02) 9980 6554
Facsimile:(02) 9484 2427
Web: www.sesl.com.au
Email: sesl@sesl.com.au

TEST	RESULT	COMMENTS
pH in KCl	9.68	Strongly alkaline
pH in H_2O_2	7.70	alkaline some pH drop
Δ pH unit	1.98	
Acidity Trail		
TPA mol H+/t	< 2	
TAA mol H+/t	< 2	
TSA mol H+/t	< 2	no excess acidity
Sulphur Trail		
% S_P	.09	
% S_{KCl}	.06	some sulphate present
% S_{POS}	.03	some sulphate released on oxidation
Derived Values		
% S_{TPA} *	< 0.01	no excess sulphuric acidity
Lime Requirement (kg/tonne) **	-0.20	

* TPA equivalent S%, where 1% sulphide produces 623.7 mole H^+ / tonne soil.
** Includes a safety factor of 1.5.

Recommendations

While there is some sulphate release on oxidation the sample clearly has sufficient excess alkali to neutralise any acid release. The material does not need to be managed as a potential acid sulphate risk.

Explanation of the Methods:
Ahern CR, Blunden B and Stone Y (eds.) (1998). *Acid Sulphate Soils Laboratory Methods* Guidelines Published by the Acid Sulphate Soil Management Advisory committe, Wollongbar, NSW, Australia

Checked by .....
S. Leake
Date of Report 14/01/2004

Consultant.....
S.Leake

SPOCAS Profile

Test Type I sPOCAS
Order No 52429 Job No: 37673
Reference Proposed Northern Extension
Sample Name Pit 201/ 13m
Sample No. 86308
Date Received 05/01/2005 Total No Pages: 1 of 1
Client: Douglas Partners (Wollongong)
Chris Wing/Arthur Castrissois
PO Box 486
UNANDERRA NSW 2526

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Web: www.sesl.com.au
Email: sesl@sesl.com.au

TEST	RESULT	COMMENTS
pH in KCl	9.14	strongly alkaline
pH in H_2O_2	8.16	alkaline
Δ pH unit	0.98	some pH drop
Acidity Trail		
TPA mol H+/t	< 2	
TAA mol H+/t	< 2	
TSA mol H+/t	< 2	no excess acidity
Sulphur Trail		
% S_P	.32	
% S_{KCl}	.04	
% S_{POS}	.28	significant release of sulphate on oxidation
Derived Values		
% S_{TPA} *	< 0.01	no net acidity
Lime Requirement (kg/tonne) **	-0.20	

* TPA equivalent S%, where 1% sulphide produces 623.7 mole H^+ / tonne soil.
** Includes a safety factor of 1.5.

Recommendations

While there is significant sulphate release on oxidation the sample clearly has sufficient excess alkali to neutralise any acid release. The material does not need to be managed as a potential acid sulphate risk.

Explanation of the Methods:
Ahern CR, Blunden B and Stone Y (eds.) (1998). *Acid Sulphate Soils Laboratory Methods* Guidelines Published by the Acid Sulphate Soil Management Advisory committe, Wollongbar, NSW, Australia

Checked by .....
S. Leake
Date of Report 14/01/2005

Consultant.....
S.Leake

SPOCAS Profile

Test Type I sPOCAS
Order No 52429 Job No: 37673
Reference Proposed Northern Extension
Sample Name Pit 202/0.5m
Sample No. 86309
Date Received 05/01/2005 Total No Pages: 1 of 1
Client: Douglas Partners (Wollongong)
Chris Wing/Arthur Castrissois
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UNANDERRA NSW 2526

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Email: sesl@sesl.com.au

TEST	RESULT	COMMENTS
pH in KCl	5.62	acidic
pH in H_2O_2	5.94	no pH drop
Δ pH unit	-0.32	
Acidity Trail		
TPA mol H+/t	< 2	
TAA mol H+/t	10	some actual acidity, very mild
TSA mol H+/t	< 2	
Sulphur Trail		
% S_P	.17	
% S_{KCl}	.09	some actual acid
% S_{POS}	.08	some sulphuric acidity
Derived Values		
% S_{TPA} *	< 0.01	no net excess of acidity
Lime Requirement (kg/tonne) **	-0.30	

* TPA equivalent S%, where 1% sulphide produces 623.7 mole H^+ / tonne soil.
** Includes a safety factor of 1.5.

Recommendations

This soil shows some potential sulphidic activity but pH does not decline (in fact increases slightly). We can only assume that the soil has sufficient buffer capacity or lime content to eliminate any pH drop. The soil does not need to be managed as a potential acid sulphate risk.

Explanation of the Methods:
Ahern CR, Blunden B and Stone Y (eds.) (1998). *Acid Sulphate Soils Laboratory Methods* Guidelines Published by the Acid Sulphate Soil Management Advisory committe, Wollongbar, NSW, Australia

Checked by .....
S. Leake
Date of Report 14/01/2005

Consultant.....
S.Leake

SPOCAS Profile

Test Type I sPOCAS
Order No 52429 Job No: 37673
Reference Proposed Northern Extension
Sample Name Pit 203/5m
Sample No. 86310
Date Received 05/01/2005 Total No Pages: 1 of 1
Client: Douglas Partners (Wollongong)
Chris Wing/Arthur Castrissois
PO Box 486
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Email: sesl@sesl.com.au

TEST	RESULT	COMMENTS
pH in KCl	5.79	slightly acidic
pH in H_2O_2	5.35	some pH decline
Δ pH unit	0.44	
Acidity Trail		
TPA mol H+/t	< 2	
TAA mol H+/t	2	some actual acidity
TSA mol H+/t	< 2	
Sulphur Trail		
% S_P	.09	
% S_{KCl}	.08	some actual sulphuric acidity
% S_{POS}	.01	very little potential sulphuric acidity
Derived Values		
% S_{TPA} *	< 0.01	no net acidity
Lime Requirement (kg/tonne) **	0.00	

* TPA equivalent S%, where 1% sulphide produces 623.7 mole H^+ / tonne soil.
** Includes a safety factor of 1.5.

Recommendations

This soil shows only a very slight potential acidity but pH does not decline to risky levels. Essentially the material is not in the potential acid sulphate category.

Explanation of the Methods:
Ahern CR, Blunden B and Stone Y (eds.) (1998) *Acid Sulphate Soils Laboratory Methods* Guidelines Published by the Acid Sulphate Soil Management Advisory committe, Wollongbar, NSW, Australia

Checked by .....
S. Leake
Date of Report 14/01/2004

Consultant.....
S.Leake

SPOCAS Profile

Test Type I sPOCAS
Order No 52429 Job No: 37673
Reference Proposed Northern Extension
Sample Name Pit 204/14m
Sample No. 86311
Date Received 05/01/2005 Total No Pages: 1 of 1
Client: Douglas Partners (Wollongong)
Chris Wing/Arthur Castrissois
PO Box 486
UNANDERRA NSW 2526

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Email: sesl@sesl.com.au

TEST	RESULT	COMMENTS
pH in KCl	6.01	slightly acidic
pH in H_2O_2	2.39	very significant pH decline
Δ pH unit	3.62	
Acidity Trail		
TPA mol H+/t	296	
TAA mol H+/t	2	little actual acidity
TSA mol H+/t	294	very significant potential sulphuric acidity
Sulphur Trail		
% S_P	1	
% S_{KCl}	.11	some actual sulphate
% S_{POS}	.89	very significant potential sulphuric acidity
Derived Values		
% S_{TPA} *	.47	some buffer capacity present in the sample
Lime Requirement (kg/tonne) **	22.20	

* TPA equivalent S%, where 1% sulphide produces 623.7 mole H^+ / tonne soil.
** Includes a safety factor of 1.5.

Recommendations

This sample is a significant potential acid sulphate risk. In the absence of any neutralising or buffer capacity the derived value of %STPA should equal %Sp. The caft that it does not indicates the presence of buffer capacity or lime in the sample. Even so there is still a significant excess of acidity and the sample must be treated as a severe acid sulphate risk. The lime requirement will theoretically gfive a resting pH of 6.5 in the oxidised sample.

Explanation of the Methods:
Ahern CR, Blunden B and Stone Y (eds.) (1998). *Acid Sulphate Soils Laboratory Methods* Guidelines Published by the Acid Sulphate Soil Management Advisory committe, Wollongbar, NSW, Australia

Checked by .....
S. Leake

Date of Report 14/01/2004

Consultant.....
S.Leake

APPENDIX E
Results of Tests of Surface and Groundwater

Analytical Report - Enviro-Managers	
Client:	**Cleary Bros (Bombo) Pty Ltd**
	Springhill Rd
Contact Name:	**Mr Ron Bryant**
Client Reference:	**Gerroa Bores**

NR = No Result - Dry

Notes	Report Number:	W05/0186	W05/0186	W05/0186	W05/0186	W05/0186	W05/0186	W05/0186	W05/0671	W05/0671	W05/0671	W05/0671	W05/0671	W05/0671	W05/0671	W05/0671	W05/0671	W05/0671
Results:	**Sample Received:**	**20/01/05**	**20/01/05**	**20/01/05**	**20/01/05**	**20/01/05**	**20/01/05**	**20/01/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**	**24/02/05**
Client Id		**Ex Works**	**BH 1**	**BH 7**	**BH 9**	**BH 11**	**B/Angel Creek**	**BH 12**	**Ex.Works**	**Bore Hole 1**	**Bore Hole 2**	**Bore Hole 4**	**Bore Hole 5**	**Bore Hole 6**	**Bore Hole 7**	**Bore Hole 9**	**Bore Hole 11**	**lue Angle Cree**
Laboratory Id		W11016/001	W11016/002	W11016/003	W11016/004	W11016/005	W11016/006	W11016/007	W11511/001	W11511/002	W11511/003	W11511/004	W11511/005	W11511/006	W11511/007	W11511/008	W11511/009	W11511/010
Conductivity (uS/cm)																		
Method:APHA 2510 B	***Units:uS/cm@25℃***	560	1030	160	860	1110	+20000	430	540	370	NR	NR	NR	NR	150	380	1510	810
Groundwater level (RL)																		
Method:	***Units:m***	-	0.48	-0.46	-1.15	-1.53	-	-0.40	-	1.83	-	-	-	-	-0.01	-0.60	-1.28	-
pH																		
Method:APHA 4500 H B	***Units:pH units***	7.8	6.6	5.7	6.4	6.4	6.9	5.4	7.5	5.7	-	-	-	-	5.6	6.5	4.9	6.3

Notes	Report Number:	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2033-1	W05/2358	W05/2358	W05/2358	W05/2358	W05/2358
Results:	**Sample Received:**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**26/05/05**	**22/06/05**	**22/06/05**	**22/06/05**	**22/06/05**	**22/06/05**
Client Id		**Ex-Works**	**BH 1**	**BH 2**	**BH 4**	**BH 5**	**BH 6**	**BH 7**	**BH 9**	**BH 11**	**B/Angel Cree**	**BH 12**	**BH 14**	**Ex Works**	**BH 1**	**BH 2**	**BH 4**	**BH 5**
Laboratory Id		W12828/001	W12828/002	W12828/003	W12828/004	W12828/005	W12828/006	W12828/007	W12828/008	W12828/009	W12828/010	W12828/011	W12828/012	W13143/001	W13143/002	W13143/003	W13143/004	W13143/005
Conductivity (uS/cm)																		
Method:APHA 2510 B	***Units:uS/cm@25℃***	540	340	NR	NR	NR	NR	190	250	1900	4240	380	NR	560	360	NR	NR	NR
Groundwater level (RL)																		
Method:	***Units:m***	-	+1.73	-	-	-	-	-0.16	-0.75	-1.33	-	-0.05	-	-	1.33	-	-	-
pH																		
Method:APHA 4500 H B	***Units:pH units***	6.8	5.8	-	-	-	-	5.8	6.1	4.6	6.4	5.8	-	6.7	5.8	-	-	-

Notes	Report Number:	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3572-2	W05/3963	W05/3963	W05/3963	W05/3963
Results:	**Sample Received:**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/09/05**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**
Client Id		**Ex.Works**	**BH 1**	**BH 1A**	**BH 4**	**BH 5**	**BH 6**	**BH 7**	**BH 9**	**BH 11**	**B/Angel Cree**	**BH 12**	**BH 2A**	**BH 3A**	**Ex.Works**	**BH 1**	**BH 1A**	**BH 4**
Laboratory Id		W14389/001	W14389/002	W14389/003	W14389/004	W14389/005	W14389/006	W14389/007	W14389/008	W14389/009	W14389/010	W14389/011	W14389/012	W14389/013	W14768/001	W14768/002	W14768/003	W14768/004
Conductivity (uS/cm)																		
Method:APHA 2510 B	***Units:uS/cm@25℃***	580	640	NR	750	NR	NR	160	270	1280	18030	770	NR	NR	600	1010	Dry	Dry
Groundwater level (RL)																		
Method:	***Units:m***	-	1.39	-	-0.33	-	-	-0.29	-0.87	-1.42	-	-0.26	-	-	-	1.05	-	-
pH																		
Method:APHA 4500 H B	***Units:pH units***	6.7	5.8	-	6.9	-	-	5.5	6.0	5.3	6.8	5.3	-	-	6.9	6.0	-	-

YEARLY SAMPLING

	Report Number:	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442	W05/4442
Results:	**Sample Received:**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**	**21/11/05**
Client Id		**Ex-Works**	**BH 1**	**BH 3A**	**BH 4**	**BH 5**	**BH 6**	**BH7**	**BH 9**	**BH 11**	**ue Angle Cre**	**BH 12**	**BH 2A**	**BH 1A**
Laboratory Id		W15175/001	W15175/002	W15175/003	W15175/004	W15175/005	W15175/006	W15175/007	W15175/008	W15175/009	W15175/010	W15175/011	W15175/012	W15175/013
Cl : SO4 Ratio														
Method:	***Units:-***	0.53	4.4	NR	5.1	NR	NR	3.3	0.88	3.6	7.4	0.56	NR	NR
Conductivity (uS/cm)														
Method:APHA 2510 B	***Units:uS/cm@25℃***	690	590	-	1080	-	-	170	410	1180	>20,000	570	-	-
Groundwater level (RL)														
Method:	***Units:m***	-	1.33	-	0.57	-	-	-0.42	-1.08	-1.30	-	-0.31	-	-
pH														
Method:APHA 4500 H B	***Units:pH units***	7.7	6.9	-	7.9	-	-	6.9	7.3	6.8	7.7	6.5	-	-

Analytical Report - Enviro-Managers	
Client:	**Cleary Bros (Bombo) Pty Ltd**
	Springhill Rd
Contact Name:	**Mr Ron Bryant**
Client Reference:	**Gerroa Bores**

NR = No Result - Dry

Notes	Report Number:	W05/0671	W05/0671	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1086-1	W05/1620	W05/1620	W05/1620
Results:	**Sample Received:**	**24/02/05**	**24/02/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**22/03/05**	**27/04/05**	**27/04/05**	**27/04/05**
Client Id		**Bore Hole 12**	**Bore Hole 14**	**Ex Works**	**BH 1**	**BH 2**	**BH 4**	**BH 5**	**BH 6**	**BH 7**	**BH 9**	**BH 11**	**lue Angle cree**	**BH 12**	**BH 14**	**Ex-Works**	**BH1**	**BH2**
Laboratory Id		W11511/011	W11511/012	W11945/001	W11945/002	W11945/003	W11945/004	W11945/005	W11945/006	W11945/007	W11945/008	W11945/009	W11945/010	W11945/011	W11945/012	W12413/001	W12413/002	W12413/003
Conductivity (uS/cm)																		
Method:APHA 2510 B	***Units:uS/cm@25℃***	350	NR	530	290	NR	NR	NR	NR	160	450	820	9140	330	NR	510	300	NR
Groundwater level (RL)																		
Method:	***Units:m***	-0.15	-	-	1.73	-	-	-	-	-0.16	-0.80	-1.48	-	-0.20	-	-	+1.53	-
pH																		
Method:APHA 4500 H B	***Units:pH units***	5.3	-	6.6	6.0	-	-	-	-	5.9	6.9	5.9	6.7	5.3	-	7.3	6.5	-

Notes	Report Number:	W05/2358	W05/2358	W05/2358	W05/2358	W05/2358	W05/2358	W05/2358	W05/2774	W05/2774	W05/2774	W05/2774	W05/2774	W05/2774	W05/2774	W05/2774	W05/2774	W05/2774
Results:	**Sample Received:**	**22/06/05**	**22/06/05**	**22/06/05**	**22/06/05**	**22/06/05**	**22/06/05**	**22/06/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**	**21/07/05**
Client Id		**BH 6**	**BH 7**	**BH 9**	**BH 11**	**ue Angel Cre**	**BH 12**	**BH 14**	**Ex Works**	**BH 1**	**BH 2**	**BH 4**	**BH 5**	**BH 6**	**BH 7**	**BH 9**	**BH 11**	**ue Angel Cre**
Laboratory Id		W13143/006	W13143/007	W13143/008	W13143/009	W13143/010	W13143/011	W13143/012	W13573/001	W13573/002	W13573/003	W13573/004	W13573/005	W13573/006	W13573/007	W13573/008	W13573/009	W13573/010
Conductivity (uS/cm)																		
Method:APHA 2510 B	***Units:uS/cm@25℃***	NR	210	220	900	>20,000	NR	NR	550	440	NR	740	100	NR	160	220	2150	5200
Groundwater level (RL)																		
Method:	***Units:m***	-	-0.31	-0.95	-0.88	-	-	-	-	1.73	-	0.07	0.23	-	0.09	-0.50	-1.48	-
pH																		
Method:APHA 4500 H B	***Units:pH units***	-	5.6	6.0	5.4	6.5	-	-	7.0	5.7	-	6.4	5.0	-	5.4	5.7	4.9	6.4

Notes	Report Number:	W05/3963	W05/3963	W05/3963	W05/3963	W05/3963	W05/3963	W05/3963	W05/3963	W05/3963	W05/4819	W05/4819	W05/4819	W05/4819	W05/4819	W05/4819	W05/4819	W05/4819
Results:	**Sample Received:**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**	**21/10/05**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**
Client Id		**BH 5**	**BH 6**	**BH 7**	**BH 9**	**BH 11**	**ue Angle Cre**	**BH 12**	**BH 2A**	**BH 3A**	**Ex-Works**	**BH 1**	**BH 1A**	**BH 4**	**BH 5**	**BH 6**	**BH 7**	**BH 9**
Laboratory Id		W14768/005	W14768/006	W14768/007	W14768/008	W14768/009	W14768/010	W14768/011	W14768/012	W14768/013	W15693/001	W15693/002	W15693/003	W15693/004	W15693/005	W15693/006	W15693/007	W15693/008
Conductivity (uS/cm)																		
Method:APHA 2510 B	***Units:uS/cm@25℃***	Dry	Lost	170	260	1010	>20,000	620	Dry	Dry	670	470	Dry	1110	Dry	NR	140	380
Groundwater level (RL)																		
Method:	***Units:m***	-	-	-0.41	-1.07	-1.33	-	-0.37	-	-	-	1.21	-	-0.43	-	-	-0.40	-0.98
pH																		
Method:APHA 4500 H B	***Units:pH units***	-	-	5.6	5.6	5.2	6.6	5.3	-	-	7.7	6.1	-	7.2	-	-	5.9	6.7

YEARLY SAMPLING

	Report Number:
Results:	**Sample Received:**
Client Id	
Laboratory Id	
Cl : SO4 Ratio	
Method:	***Units:-***
Conductivity (uS/cm)	
Method:APHA 2510 B	***Units:uS/cm@25℃***
Groundwater level (RL)	
Method:	***Units:m***
pH	
Method:APHA 4500 H B	***Units:pH units***

Analytical Report - Enviro-Managers	
Client:	**Cleary Bros (Bombo) Pty Ltd**
	Springhill Rd
Contact Name:	**Mr Ron Bryant**
Client Reference:	**Gerroa Bores**

NR = No Result - Dry

Notes	Report Number:	W05/1620	W05/1620	W05/1620	W05/1620	W05/1620	W05/1620	W05/1620	W05/1620	W05/1620
Results:	**Sample Received:**	**27/04/05**	**27/04/05**	**27/04/05**	**27/04/05**	**27/04/05**	**27/04/05**	**27/04/05**	**27/04/05**	**27/04/05**
Client Id		**BH4**	**BH5**	**BH6**	**BH7**	**BH9**	**BH11**	**B/Angle Creek**	**BH12**	**BH14**
Laboratory Id		W12413/004	W12413/005	W12413/006	W12413/007	W12413/008	W12413/009	W12413/010	W12413/011	W12413/012
Conductivity (uS/cm)										
Method:APHA 2510 B	***Units:uS/cm@25℃***	NR	NR	NR	140	400	790	7380	410	NR
Groundwater level (RL)										
Method:	***Units:m***	-	-	-	-0.31	-0.95	-1.53	-	-1.30	-
pH										
Method:APHA 4500 H B	***Units:pH units***	-	-	-	5.6	6.5	5.6	6.9	5.9	-

Notes	Report Number:	W05/2774	W05/2774	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172	W05/3172
Results:	**Sample Received:**	**21/07/05**	**21/07/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**	**22/08/05**
Client Id		**BH 12**	**BH 14**	**WM1A**	**xisting Work**	**WM1**	**WM2A**	**WM4**	**WM5**	**WM3A**	**WM7**	**WM9**	**WM11**	**ue Angle Cre**	**WM12**
Laboratory Id		W13573/011	W13573/012	W13973/001	W13973/002	W13973/003	W13973/004	W13973/005	W13973/006	W13973/007	W13973/008	W13973/009	W13973/010	W13973/011	W13973/012
Conductivity (uS/cm)															
Method:APHA 2510 B	***Units:uS/cm@25℃***	NR	NR	NR	560	670	NR	780	NR	NR	160	250	1360	8540	760
Groundwater level (RL)															
Method:	***Units:m***	-	-	-	-	1.12	-	0.78	-	-	-0.14	-0.72	-1.29	-	-0.17
pH															
Method:APHA 4500 H B	***Units:pH units***	-	-	-	7.0	6.0	-	6.8	-	-	5.6	5.5	4.5	6.7	5.4

Notes	Report Number:	W05/4819	W05/4819	W05/4819	W05/4819	W05/4819
Results:	**Sample Received:**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**	**20/12/05**
Client Id		**BH 11**	**ue Angle Cre**	**BH 12**	**BH 2A**	**BH 3A**
Laboratory Id		W15693/009	W15693/010	W15693/011	W15693/012	W15693/013
Conductivity (uS/cm)						
Method:APHA 2510 B	***Units:uS/cm@25℃***	1230	17420	590	Dry	Dry
Groundwater level (RL)						
Method:	***Units:m***	-1.44	-	-0.17	-	-
pH						
Method:APHA 4500 H B	***Units:pH units***	5.7	7.0	5.3	-	-

YEARLY SAMPLING

	Report Number:
Results:	**Sample Received:**
Client Id	
Laboratory Id	
Cl : SO4 Ratio	
Method:	***Units:-***
Conductivity (uS/cm)	
Method:APHA 2510 B	***Units:uS/cm@25℃***
Groundwater level (RL)	
Method:	***Units:m***
pH	
Method:APHA 4500 H B	***Units:pH units***

TABLE 1: Surface Water Analytical Results

Foys Swamp, Blue Angle Creek and Gerroa Sand Quarry

Cleary Bros (Bombo) Pty Ltd	*Water Monitoring Program*			Sample ID	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	BA Creek	BA Creek	BA Creek
				Sample ID	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-dn stream	Main Drain-dn stream	Main Drain-dn stream	Main Drain- dn stream	Main Drain- dn stream	Main Drain- dn stream	Main Drain- dn stream	Blue Angle Creek	Blue Angle Creek	Blue Angle Creek
	Units	LOR	ANZECC 2000 Guidelines		Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather
Metals (total)			Marine	Fresh	27/01/05	28/04/05	2/06/05	3/08/05	21/09/05	21/10/06	21/11/05	27/01/05	28/04/05	2/06/05	3/08/05	21/09/05	21/10/06	21/11/05	3/02/05	28/04/05	2/06/05
Aluminium (PH>6.5,)	mg/L	0.0001	ID	0.055			**0.99**	**2.7**			**0.26**			**0.56**	**0.4**			**0.12**			**0.59**
Arsenic	mg/L	0.001	ID	0.013	<0.001		<0.001	<0.001			<0.001	0.002		<0.001	<0.001			<0.001	0.002		0.004
Beryllium	mg/L	0.001	ID	ID	<0.001							<0.001							0.001		
Barium	mg/L	0.001	ID	ID	0.016							0.015							0.014		
Cadmium	mg/L	0.0001	0.0007	0.0002	0.0002		<0.0001	<0.0001			<0.001	**0.0003**		<0.0001	<0.0001			<0.001	**0.0004**		<0.0001
Chromium (Total)	mg/L	0.001	0.0274	ID	0.003		<0.001	0.001				0.003		<0.001	<0.001				0.003		<0.001
Cobalt	mg/L	0.001	0.001	ID	0.01							0.009							**0.004**		
Copper	mg/L	0.001	0.0013	0.0014	<0.001		**0.003**	**0.006**			<0.001	<0.001		**0.003**	**0.002**			<0.001	**0.01**		**0.006**
Lead	mg/L	0.001	0.0044	0.0034	<0.001		<0.001	<0.001			<0.001	<0.001		<0.001	<0.001			<0.001	0.01		<0.001
Zinc	mg/L	0.005	0.015	0.008	**0.013**		**0.012**	**0.031**			<0.005	**0.012**		**0.023**	**0.009**			<0.005	**0.023**		**0.022**
Manganese	mg/L	0.001	ID	1.9	0.596							0.543							0.14		
Nickel	mg/L	0.001	0.007	0.011	0.01							0.009							0.006		
Vanadium	mg/L	0.01	0.1	ID	<0.01							<0.01							<0.01		
Total Iron	mg/L	0.005	ID	ID	0.75		0.71	2.48			0.30	0.42		0.49	0.52			0.11	<0.1		2.07
Mercury	mg/L	0.0001	0.0001	0.00006	<0.0001		<0.0001	<0.0001			<0.0005	<0.0001		<0.0001	<0.0001			<0.0005	0.0001		<0.0001
Weak Acid Dissociable Cyanide	mg/L	0.005	0.004	0.007	- - -							<0.0050							- - -		
Nutrients																					
Fluoride	mg/L	0.1			- - -							- - -							0.1	- - -	
Ammonia as N	mg/L	0.01	0.91	0.9	0.052	0.028	0.073	0.084	0.18	<0.02	0.25	0.096	0.031	0.047	0.02	0.17	0.02	0.19	0.048	0.282	0.53
Nitrate as N	mg/L	0.01	ID	0.7	<0.010	<0.010	0.026	0.014	<0.04	0.05	<0.04	<0.010	<0.010	<0.010	0.023	<0.04	0.09	<0.04	<0.010	0.062	<0.010
Nitrite as N	mg/L	0.01			<0.010		<0.010	0.013	<0.002	0.014	0.004	<0.010	<0.010	<0.010	<0.010	<0.002	0.014	0.005	0.014	<0.010	0.026
Total Kjeldahl Nitrogen as N	mg/L	0.10			0.80	0.60	2.40	2.20	0.84	0.53	0.63	0.70	0.50	0.90	0.60	0.86	0.48	0.47	1.80	1.00	2.30
Total Phosphorus as P	mg/L	0.01		0.05	0.04	0.01	**0.25**	**1.02**	<0.005	<0.005	<0.005	0.01	<0.010	0.02	<0.01	<0.005	<0.005	<0.005	**0.18**	**0.06**	**0.28**
Reactive Phosphorus	mg/L	0.01			<0.010	<0.01	<0.010	<0.010	<0.004	<0.004	<0.004	0.912	<0.010	<0.010	<0.010	<0.004	<0.004	<0.004	- - -	<0.010	<0.010
PH (lab)	pH Unit	0.01			- - -	6.17	6.72	6.33	7.20	7.00	6.80	- - -	6.90	6.71	6.68	7.00	7.00	6.90	- - -	6.80	6.87
Total Dissolved Solids (TDS)	mg/L	1			552	2460	646	1230	***4515.8***	***5808.9***	***3577.8***	- - -	1240	644	1730	***3912.8***	***5453.8***	***4127.2***	303	2330	18500
Electrical Conductivity	uS/cm	1							6740	8670	5340					5840	8140	6160			
Suspended Solids (SS)	mg/L	1			11	7		3				6	10		9				23	13	
Total Hardness	mg/L	1			164	- - -						- - -							73		
Major Ions																					
Calcium	mg/L	1			28		37				53	- - -						63	13		225
Magnesium	mg/L	1			20		26				93	- - -						110	10		587
Sodium	mg/L	1			87		134				669	- - -						789	39		4460
Potassium	mg/L	1			10		10				31	- - -						36	6		176
Bicarbonate as CaCO3	mg/L	1			2		31					- - -							10		90
Total Alkalinity	mg/L	1			2		31					- - -							10		90
Sulphate as SO4	mg/L	1			159		182				293	- - -						392	63		1200
Chloride	mg/L	1			130		212				1308	- - -						1684	64.5		8930
SAR																					
Calcium + Magnesium (meq/L)					3.04		3.99				10.29	- - -						12.19	1.47		59.51
Sodium (meq/L)					3.78		5.83				29.10	- - -						34.32	1.70		194.01
SAR= Na / Sqrt (Ca+ Mg) / 2)					1.23		1.41				2.27	- - -						2.47	0.86		5.46
SAR- Sodium Absorption Ratio					**3.07**		**4.13**				**12.83**	**- - -**						**13.90**	**1.98**		**35.57**
SAR Hazard Ranking					**Low**		**Low**				**Med**							**Med**	**Low**		**V High**

Note:

SAR Hazard ranking based on Fetter, 1994.

Low = 2 to 10, Med = 7 to 18, High= 11 to 26, V High= 26+

nr - no recommended NSW guidelines NA - Not Available

TDS= EC*0.67 (approximate) calculation in italics (Data from Sept to Dec05)

3 3 Exceeds ANZECC 2000 trigger values (marine and/or fresh water)

TABLE 1: Surface Water Analytical Results

Foys Swamp, Blue Angle Creek and Gerroa Sand Quarry

Cleary Bros (Bombo) Pty Ltd	***Water Monitoring Program***			Sample ID	BA Creek	BA Creek	BA Creek	BA Creek	SW Drain	SW Drain	SW Drain
				Sample ID	Blue Angle Creek	Blue Angle Creek	Blue Angle Creek	Blue Angle Creek	SW Drain	SW Drain	SW Drain
	Units	LOR	ANZECC 2000 Guidelines		Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather
Metals (total)			Marine	Fresh	3/08/05	21/09/05	21/10/06	21/11/05	27/01/05	2/06/05	21/11/2005
Aluminium (PH>6.5,)	mg/L	0.0001	ID	0.055	**1.47**			**0.02**			
Arsenic	mg/L	0.001	ID	0.013	0.003			<0.001	0.004		
Beryllium	mg/L	0.001	ID	ID					<0.001		
Barium	mg/L	0.001	ID	ID					0.019		
Cadmium	mg/L	0.0001	0.0007	0.0002	<0.0001			<0.001	<0.0001		
Chromium (Total)	mg/L	0.001	0.0274	ID	0.001				0.003		
Cobalt	mg/L	0.001	0.001	ID					**0.002**		
Copper	mg/L	0.001	0.0013	0.0014	**0.008**			<0.001	**0.002**		
Lead	mg/L	0.001	0.0044	0.0034	<0.001			<0.001	<0.001		
Zinc	mg/L	0.005	0.015	0.008	**0.016**			<0.005	**0.412**		
Manganese	mg/L	0.001	ID	1.9					0.003		
Nickel	mg/L	0.001	0.007	0.011					<0.01		
Vanadium	mg/L	0.01	0.1	ID					<0.005		
Total Iron	mg/L	0.005	ID	ID	7.12			0.28	2.16		
Mercury	mg/L	0.0001	0.0001	0.00006	<0.0001			<0.0005	<0.0001		
Weak Acid Dissociable Cyanide	mg/L	0.005	0.004	0.007					- - -		
Nutrients											
Fluoride	mg/L	0.1							- - -		
Ammonia as N	mg/L	0.01	0.91	0.9	0.652	0.22	0.12	0.26	0.074	0.096	0.15
Nitrate as N	mg/L	0.01	ID	0.7	0.231	0.05	0.08	<0.04	<0.010	0.016	<0.04
Nitrite as N	mg/L	0.01			0.114	0.005	0.021	0.004	0.012	<0.010	0.11
Total Kjeldahl Nitrogen as N	mg/L	0.10			0.90	0.73	0.58	0.44	- - -	1.50	1.5
Total Phosphorus as P	mg/L	0.01		0.05	0.05	<0.005	<0.005	<0.005	**0.31**	**0.13**	0.05
Reactive Phosphorus	mg/L	0.01			<0.010	<0.004	<0.004	<0.004	- - -	0.123	0.043
PH (lab)	pH Unit	0.01			6.89	7.00	6.90	6.70	- - -	6.87	7.5
Total Dissolved Solids (TDS)	mg/L	1			3620	***3752***	***7624.6***	***4107.1***	203	243	520
Electrical Conductivity	uS/cm	1				5600	11380	6130			
Suspended Solids (SS)	mg/L	1			26				20		
Total Hardness	mg/L	1							52		
Major Ions											
Calcium	mg/L	1						63	10		
Magnesium	mg/L	1						111	7		
Sodium	mg/L	1						808	26		
Potassium	mg/L	1						37	7		
Bicarbonate as CaCO3	mg/L	1							39		
Total Alkalinity	mg/L	1							39		
Sulphate as SO4	mg/L	1						345	8		
Chloride	mg/L	1						1635	49		
SAR											
Calcium + Magnesium (meq/L)								12.27	1.07		
Sodium (meq/L)								35.15	1.13		
SAR= Na / Sqrt (Ca+ Mg) / 2)								2.48	0.73		
SAR- Sodium Absorption Ratio								**14.19**	**1.54**		
SAR Hazard Ranking								**Med**	**Low**		

Note:
SAR Hazard ranking based on Fetter, 1994.
Low = 2 to 10, Med = 7 to 18, High= 11 to 26, V High= 26+
nr - no recommended NSW guidelines NA - Not Available
TDS= EC*0.67 (approximate) calculation in italics (Data from Sept to Dec05)

TABLE 1: Surface Water Analytical Results

Foys Swamp, Blue Angle Creek and Gerroa Sand Quarry

Cleary Bros (Bombo) Pty Ltd	***Water Monitoring Program***			Sample ID	W Drain	W Drain	W Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	Dredge Pond	Dredge Pond	Dredge Pond	Dredge Pond	Dredge Pond	Dredge Pond
				Sample ID	W Drain	W Drain	W Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	MD Pond	MD Pond	MD Pond	MD Pond	MD Pond	MD Pond
	Units	LOR	ANZECC 2000 Guidelines		Wet Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather
Metals (total)			Marine	Fresh	27/01/2005	2/06/2005	21/11/2005	27/01/2005	2/06/05	3/08/05	21/09/05	21/10/05	21/11/05	27/01/05	2/06/05	3/08/05	21/09/05	21/10/05	21/11/05
Aluminium (PH>6.5,)	mg/L	0.0001	ID	0.055					**3.04**	**2.83**			**18**		**1.42**	**1.28**			**1.9**
Arsenic	mg/L	0.001	ID	0.013	0.003			<0.001	<0.001	<0.001			<0.001	0.004	0.003	0.002			<0.001
Beryllium	mg/L	0.001	ID	ID	<0.001			0.002						<0.001					
Barium	mg/L	0.001	ID	ID	0.03			0.028						0.01					
Cadmium	mg/L	0.0001	0.0007	0.0002	**0.0005**			**0.0003**	<0.0001	<0.0001			<0.001	0.0002	<0.0001	<0.0001			<0.001
Chromium (Total)	mg/L	0.001	0.0274	ID	0.003			0.002	<0.001	<0.001				0.004	0.002	0.001			
Cobalt	mg/L	0.001	0.001	ID	<0.001			**0.038**						<0.001					
Copper	mg/L	0.001	0.0013	0.0014	**0.025**			**0.003**	**0.002**	**0.004**			**0.002**	<0.001	**0.002**	**0.003**			<0.001
Lead	mg/L	0.001	0.0044	0.0034	0.001			<0.001	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001			<0.001
Zinc	mg/L	0.005	0.015	0.008	**0.072**			**1.72**	**0.035**	**0.019**			**0.053**	0.015	**0.05**	**0.012**			<0.005
Manganese	mg/L	0.001	ID	1.9	0.004			0.028						0.003					
Nickel	mg/L	0.001	0.007	0.011	<0.01			<0.01						<0.01					
Vanadium	mg/L	0.01	0.1	ID	**0.022**			0.045						<0.005					
Total Iron	mg/L	0.005	ID	ID	0.83			8.64	0.39	1.4			0.58	0.77	1.14	0.78			0.57
Mercury	mg/L	0.0001	0.0001	0.00006	<0.0001			**0.0016**	<0.0001	<0.0001			<0.0005	<0.0001	<0.0001	<0.0001			<0.0005
Weak Acid Dissociable Cyanide	mg/L	0.005	0.004	0.007	- - -			- - -						<0.0050					
Nutrients																			
Fluoride	mg/L	0.1			- - -			- - -						0.2					
Ammonia as N	mg/L	0.01	0.91	0.9	0.055	0.043	0.35	0.066	0.046	0.059	0.23	<0.02	0.31	0.063	0.038	<0.010	0.20	0.03	0.19
Nitrate as N	mg/L	0.01	ID	0.7	0.011	<0.010	<0.04	<0.010	0.301	<0.010	<0.04	<0.04	<0.04	0.023	<0.010	0.025	<0.04	0.04	<0.04
Nitrite as N	mg/L	0.01			<0.010	<0.010	0.022	<0.010	<0.010	<0.010	<0.002	0.014	<0.002	<0.010	<0.010	<0.010	0.034	0.022	0.027
Total Kjeldahl Nitrogen as N	mg/L	0.10			- - -	1.00	5.7	- - -	1.20	2.10	0.62	0.50	0.46	0.60	0.60	0.40	0.57	0.46	0.39
Total Phosphorus as P	mg/L	0.01		0.05	**0.18**	**0.12**	**0.4**	**0.08**	0.03	**0.35**	0.006	<0.005	<0.005	0.02	0.02	<0.01	0.014	0.026	<0.005
Reactive Phosphorus	mg/L	0.01			- - -	0.066	<0.004	- - -	<0.010	<0.010	<0.004	<0.004	<0.004	- - -	0.01	<0.010	<0.004	0.016	<0.004
PH (lab)	pH Unit	0.01			- - -	7.43	8.20	- - -	4.43	5.06	6.40	6.40	3.80	- - -	7.06	7.47	7.60	7.40	7.50
Total Dissolved Solids (TDS)	mg/L	1			306	220	720	914	406	410	***1742***	***2639.8***	***1815.7***	360	324	336	***406.69***	***425.45***	***589.6***
Electrical Conductivity	uS/cm	1									2600	3940	2710				607	635	880
Suspended Solids (SS)	mg/L	1			21			31		50				11		7			
Total Hardness	mg/L	1			103			212						- - -					
Major Ions																			
Calcium	mg/L	1			24			32	18				60	43	42				47
Magnesium	mg/L	1			10			32	17				65	12	11				14
Sodium	mg/L	1			41			123	78				257	46	42				51
Potassium	mg/L	1			7			10	4				12	4	4				5.2
Bicarbonate as CaCO3	mg/L	1			75			<1	<1					48	47				
Total Alkalinity	mg/L	1			75			<1	<1					48	47				
Sulphate as SO4	mg/L	1			32			264	140				533	109	104				134
Chloride	mg/L	1			61.1			166	110				445	65.5	71				82
SAR																			
Calcium + Magnesium (meq/L)					2.02			4.23	2.30				8.34	3.13	3.00				3.50
Sodium (meq/L)					1.78			5.35	3.39				11.18	2.00	1.83				2.22
SAR= Na / Sqrt (Ca+ Mg) / 2)					1.01			1.45	1.07				2.04	1.25	1.22				1.32
SAR- Sodium Absorption Ratio					**1.77**			**3.68**	**3.17**				**5.47**	**1.60**	**1.49**				**1.68**
SAR Hazard Ranking					**Low**			**Low**	**Low**				**Low**	**Low**	**Low**				**Low**

Note:
SAR Hazard ranking based on Fetter, 1994.
Low = 2 to 10, Med = 7 to 18, High= 11 to 26, V High= 26+
nr - no recommended NSW guidelines NA - Not Available
TDS= EC*0.67 (approximate) calculation in italics (Data from Sept to Dec05)

Table 1D - Gerroa Monthly Groundwater Results (BH 1-6)

Client Reference: **Gerroa Bores**

NR = No Result - Dry

Notes	Report Number:	W05/0186	W05/0671	W05/1086-1	W05/1620	W05/2033-1	W05/2358	W05/2774	W05/3172	W05/3572-2	W05/3963	W05/4442	W05/4819			
Results:	Sample Receive	20/01/2005	24/02/2005	22/03/2005	27/04/2005	26/05/2005	22/06/2005	21/07/2005	22/08/2005	21/09/2005	21/10/2005	21/11/2005	20/12/2005			
Client Id		BH 1	BH 1	BH 1	BH1	BH 1	BH 1	BH 1	WM1	BH 1	BH 1	BH 1	BH 1	Minimum	Average	Maximim
Laboratory Id		W11016/002	W11511/002	W11945/002	W12413/002	W12828/002	W13143/002	W13573/002	W13973/003	W14389/002	W14768/002	W15175/002	W15693/002			
Conductivity (uS/cm)																
Method:APHA 2510 B	***Units:uS/cm@25***	1030	370	290	300	340	360	440	670	640	1010	590	470	290	531	1030
Groundwater level (RL)																
Method:	***Units:m***	0.48	1.83	1.73	1.53	1.73	1.33	1.73	1.12	1.39	1.05	1.33	1.21	0.48	1.39	1.83
pH																
Method:APHA 4500 H B	***Units:pH units***	6.60	5.70	6.00	6.50	5.80	5.80	5.70	6.0	5.80	6.00	6.90	6.1	5.70	6.08	6.90

Notes	Report Number:	W05/3172	W05/3572-2	W05/3963	W05/4442	W05/4819	W05/0671	W05/1086-1	W05/1620	W05/2033-1	W05/2358	W05/2774	W05/3172	W05/3572-2	W05/3963	W05/4442
Results:	Sample Receive	22/08/2005	21/09/2005	21/10/2005	21/11/2005	20/12/2005	24/02/2005	22/03/2005	27/04/2005	26/05/2005	22/06/2005	21/07/2005	22/08/2005	21/09/2005	21/10/2005	21/11/2005
Client Id		WM3A	BH 3A	BH 3A	BH3A	BH 3A	BH 4	BH 4	BH4	BH 4	BH 4	BH 4	WM4	BH 4	BH 4	BH4
Laboratory Id		W13973/007	W14389/013	W14768/013	W15175/003	W15693/013	W11511/004	W11945/004	W12413/004	W12828/004	W13143/004	W13573/004	W13973/005	W14389/004	W14768/004	W15175/004
Conductivity (uS/cm)																
Method:APHA 2510 B	***Units:uS/cm@25***	NR	NR	Dry	NR	Dry	NR	NR	NR	NR	NR	740	780	750	Dry	1080
Groundwater level (RL)																
Method:	***Units:m***	-	-	-	-	-	-	-	-	-	-	0.07	0.78	-0.33	-	0.57
pH																
Method:APHA 4500 H B	***Units:pH units***	-	-	-	-	-	-	-	-	-	-	6.4	6.8	6.9	-	7.90

Notes	Report Number:	W05/0671	W05/1086-1	W05/1620	W05/2033-1	W05/2358	W05/2774	W05/3572-2	W05/3963	W05/4442	W05/4819
Results:	Sample Receive	24/02/2005	22/03/2005	27/04/2005	26/05/2005	22/06/2005	21/07/2005	21/09/2005	21/10/2005	21/11/2005	20/12/2005
Client Id		BH 6	BH 6	BH6	BH 6	BH 6	BH 6	BH 6	BH 6	BH6	BH 6
Laboratory Id		W11511/006	W11945/006	W12413/006	W12828/006	W13143/006	W13573/006	W14389/006	W14768/006	W15175/006	W15693/006
Conductivity (uS/cm)											
Method:APHA 2510 B	***Units:uS/cm@25***	NR	NR	NR	NR	NR	NR	NR	Lost	NR	NR
Groundwater level (RL)											
Method:	***Units:m***	-	-	-	-	-	-	-	-	-	-
pH											
Method:APHA 4500 H B	***Units:pH units***	-	-	-	-	-	-	-	-	-	-

Table 1D - Gerroa Mon

Client Reference: **Gerroa Bor**

NR = No Result - Dry

Notes	Report Number:	W05/3172	W05/3572-2	W05/3963	W05/4442	W05/0671	W05/1086-1	W05/1620	W05/2033-1	W05/2358	W05/2774	W05/3572-2	W05/3963	W05/4442	W05/4819
Results:	**Sample Receive**	**22/08/2005**	**21/09/2005**	**21/10/2005**	**21/11/2005**	**24/02/2005**	**22/03/2005**	**27/04/2005**	**26/05/2005**	**22/06/2005**	**21/07/2005**	**21/09/2005**	**21/10/2005**	**21/11/2005**	**20/12/2005**
Client Id		**WM1A**	**BH 1A**	**BH 1A**	**BH 1A**	**BH 2**	**BH 2**	**BH2**	**BH 2**	**BH 2**	**BH 2**	**BH 2A**	**BH 2A**	**BH 2A**	**BH 2A**
Laboratory Id		**W13973/001**	**W14389/003**	**W14768/003**	**W15175/013**	**W11511/003**	**W11945/003**	**W12413/003**	**W12828/003**	**W13143/003**	**W13573/003**	**W14389/012**	**W14768/012**	**W15175/012**	**W15693/012**
Conductivity (uS/cm)															
Method:APHA 2510 B	***Units:uS/cm@25***	NR	NR	Dry	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NR	Dry
Groundwater level (RL)															
Method:	***Units:m***	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH															
Method:APHA 4500 H B	***Units:pH units***	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes	Report Number:	W05/4819				W05/0671	W05/1086-1	W05/1620	W05/2033-1	W05/2358	W05/2774	W05/3172	W05/3572-2	W05/3963	W05/4442	W05/4819
Results:	**Sample Receive**	**20/12/2005**				**24/02/2005**	**22/03/2005**	**27/04/2005**	**26/05/2005**	**22/06/2005**	**21/07/2005**	**22/08/2005**	**21/09/2005**	**21/10/2005**	**21/11/2005**	**20/12/2005**
Client Id		**BH 4**	**Minimum**	**Average**	**Maximim**	**BH 5**	**BH 5**	**BH5**	**BH 5**	**BH 5**	**BH 5**	**WM5**	**BH 5**	**BH 5**	**BH5**	**BH 5**
Laboratory Id		**W15693/004**				**W11511/005**	**W11945/005**	**W12413/005**	**W12828/005**	**W13143/005**	**W13573/005**	**W13973/006**	**W14389/005**	**W14768/005**	**W15175/005**	**W15693/005**
Conductivity (uS/cm)																
Method:APHA 2510 B	***Units:uS/cm@25***	1110	740	892	1110	NR	NR	NR	NR	NR	100	NR	NR	Dry	NR	Dry
Groundwater level (RL)																
Method:	***Units:m***	-0.43	-0.43	0.13	0.57	-	-	-	-	-	0.23	-	-	-	-	-
pH																
Method:APHA 4500 H B	***Units:pH units***	7.2	6.4	7.04	7.90	-	-	-	-	-	5.0	-	-	-	-	-

Notes	Report Number:
Results:	**Sample Receive**
Client Id	
Laboratory Id	
Conductivity (uS/cm)	
Method:APHA 2510 B	***Units:uS/cm@25***
Groundwater level (RL)	
Method:	***Units:m***
pH	
Method:APHA 4500 H B	***Units:pH units***

Table 4- Field Chemistry Measurements- Surface Waters

Dredge Pond, Foys Swamp and Blue Angle Creek

Water Body	Lab Sample ID	Field Sample ID	Date	Decription	pH	Redox (mV)	EC (uS/cm)	TDS (mg/L)- #	DO (%)	Temp	Comments
Main Dredge Pond	M.D.Pond	FC-13	24/01/2005	Clear water	6.19	222	503	337	65	27.5	Groundwater
	M.D.Pond	FC-13	27/01/2005	Clear water	6.15	265	562	377	70	24.9	
	M.D.Pond	FC-13	2/06/2005	Clear water	6.35	190	655	439	80	8.3	(EC=1614m at 1.2m, pH 7.47)
	M.D.Pond	FC-13	3/08/2005	Clear water	6.3	185	528	354	65	17.2	dry period, low water level
	M.D.Pond	FC-13	21/10/2005	Clear water	7.73	92	298	200	95	20.92	Enviromanagers
	M.D.Pond	FC-13	21/11/2005	Clear water	7.58	96	617	413	100	23.32	Enviromanagers
	M.D.Pond	FC-13	20/12/2005	Clear water	7.86	82	647	433	99	22.83	Enviromanagers
South Dredge Pond	S.D Pond	FC-14	27/01/2005	Clear, >1m depth, no visible flow, vegetated	6.49	142	237	159	39	24.5	Vegetated, collects runoff?
	S.D Pond	FC-14	31/01/2005	Clear, >1m depth, no visible flow, vegetated	5.58	311	222	149	98	30	Vegetated, collects runoff?
GW Drain-1		FC-23	24/01/2005	clear, no visible flow, >1.5m depth 5m wide,	5.17	233	769	515	20	23.9	water level ~0.5m bgl
		FC-23	27/01/2005	clear, no visible flow, >1.5m depth 5m wide,	5.8	337	747	500	31	26.1	water level ~0.5m bgl
		FC-23	2/06/2005	clear, no visible flow, >1.5m depth 5m wide,	6.38	136	1164	780	47	14.1	water level ~0.5m bgl
		FC-27	3/08/2005	clear, no visible flow, >1.5m depth 5m wide,	6.64	-8	764	512	75	13.6	dry weather, low drain level
		FC-23	21/10/2005		7.95	73	2437	1633	100	21.24	Enviromanagers
		FC-23	21/11/2005		7.5	97	1247	835	100	21.44	Enviromanagers
		FC-23	20/12/2005		7.06	113	900	603	88	21.69	Enviromanagers
GW Drain-2		FC-18	24/01/2005	clear, no visible flow, >1.5m depth 5m wide,	6.31	158	1505	1008	50	25.3	water level ~0.5m bgl
		FC-18	27/01/2005	clear, no visible flow, >1.5m depth 5m wide,	6.3	278	1546	1036	35	26	water level ~0.5m bgl
		FC-18	3/02/2005	clear, no visible flow, >1.5m depth 5m wide,	6.19	103	1104	740	40	25	water level ~0.2m bgl
		FC-18	2/06/2005	clear, no visible flow, >1.5m depth 5m wide,	6.38	134	946	634	55	14.3	water level ~0.5m bgl
		FC-18	3/08/2005	clear, no visible flow, >1.5m depth 5m wide,	5.9	107	4070	2727	60	14.7	dry weather, low drain level
		FC-18	31/01/2005	clear, no visible flow, >1.5m depth 5m wide,	5.23	227	1534	1028	65	28.4	wet weather
	GW Drain-2	FC-19	24/01/2005	clear, no visible flow, >1.5m depth 5m wide,	6.64	162	1579	1058	55	24.1	
	GW Drain-2	FC-19	4/02/2005	clear, no visible flow, >1.5m depth 5m wide,	6.29	155	967	648	37	19.3	clear water
		FC-8	28/01/2005	shallow ditch near trees	3.62	353	3090	2070	60	29	drainage ditch, no flow
		FC-8	3/02/2005	shallow ditch near trees	4.6	14	323	216	32	27	wet weather
		FC-9	28/01/2005	shallow ditch near trees	3.33	453	2590	1735	45	33	Heavy vegetation
		FC-9	31/01/2005	shallow ditch near trees	3.34	227	1776	1190	37	31	Heavy vegetation
		FC-9	3/02/2005	shallow ditch near trees	4.73	117	288	193	47	23	wet weather
		FC-15	3/02/2005	clear, no visible flow, >1.5m depth,5m wide.	5.99	100	865	580	33	22.8	water level ~0.2m bgl
	GW Drain-2	FC-18	21/10/2005		7.85	99	7857	5264	100	20.61	Enviromanagers
	GW Drain-2	FC-18	21/11/2005		6.89	28	6574	4405	100	21.41	Enviromanagers
	GW Drain-2	FC-18	20/12/2005		7.26	118	4821	3230	85	21.69	Enviromanagers
GW Drain-3	GW Drain-3	FC-16	24/01/2005	clear, no visible flow, >1.5m depth,5m wide.	6.14	159	1320	884	60	24.6	water level ~0.5m bgl
	GW Drain-3	FC-16	2/06/2005	clear, no visible flow, >1.5m depth,5m wide.	5.02	125	1137	762	60	14.7	water level ~0.5m bgl
	GW Drain-3	FC-16	3/08/2005	clear, no visible flow, >1.5m depth,5m wide.	3.82	156	4020	2693	70	14.8	dry weather, low drain level
	GW Drain-3	FC-16	21/10/2005		8.3	94	7875	5276	100	21	Enviromanagers
	GW Drain-3	FC-16	21/11/2005		6.46	46	7976	5344	100	22.04	Enviromanagers
	GW Drain-3	FC-16	20/12/2005		7.22	102	5871	3934	90	22.87	Enviromanagers

Table 4- Field Chemistry Measurements- Surface Waters

Dredge Pond, Foys Swamp and Blue Angle Creek

Water Body	Lab Sample ID	Field Sample ID	Date	Decription	pH	Redox (mV)	EC (uS/cm)	TDS (mg/L)- #	DO (%)	Temp	Comments
GW Drain-4		FC-20	24/01/2005	Shallow <0.2m dish drain, stagnant water	3.58	339	1795	1203	50	26.1	acid waters
		FC-20	27/01/2005	Shallow <0.2m dish drain, stagnant water	3.36	475	1131	758	45	30	acid waters, rusty on bank
		FC-20	2/06/2005	Shallow <0.2m dish drain, stagnant water	4.17	310	1438	963	73	17.37	acidic, rusty on bank
	GW Drain-4	FC-10	28/01/2005	shallow drain, no flow	3.03	381	4680	3136	15	35.1	drainage ditch, no flow
		FC-11	28/01/2005	shallow drain, no flow	3.83	390	1227	822	50	34	drainage ditch, no flow
	GW Drain-4	FC-10	21/10/2005		7.7	108	12310	8248	100	21.27	Enviromanagers
	GW Drain-4	FC-10	21/11/2005		3.76	362	923	618	100	23.79	Enviromanagers
	GW Drain-4	FC-10	20/12/2005	dry							
GW Drain-5	GW Drain-5	FC-26	27/01/2005	clear, no visible flow, >1.5m depth,5m wide.	6.79	356	2117	1418	50	28	clear water
	GW Drain-5	FC-26	3/02/2005	clear, no visible flow, >1.5m depth,5m wide.full	6.39	75	1563	1047	46	21.8	clear water, wet weather flow, full drain
	GW Drain-5	FC-26	2/06/2005	clear, no visible flow, >1.5m depth,5m wide.full	7.32	173	1554	1041	51	11.4	clear water
	GW Drain-5	FC-26	3/08/2005	clear, no visible flow, >1.5m depth,5m wide	6.63	192	3250	2178	60	14.6	dry weather, low water level
		FC-7	28/01/2005	south end of drain 5	6.23	99	505	338	100	24	groundwater, deep drain, clear water
		FC-7	31/01/2005	south end of drain 5	5.41	261	863	578	50	26	groundwater, deep drain, clear water
		FC-7	3/02/2005	south end of drain 5	5.85	89	1082	725	36	19.6	groundwater, deep drain, clear water
	GW Drain-5	FC-26	21/10/2005		7.57	129	8242	5522	96	21.33	Enviromanagers
	GW Drain-5	FC-26	21/11/2005		7.54	116	7289	4884	98	22.35	Enviromanagers
	GW Drain-5	FC-26	20/12/2005		7.54	109	5331	3572	76	23.09	Enviromanagers
Drain-6	GWDrain-6		3/08/2005	slight flow (1L/min)	6.93	103	2120	1420	75	14.3	dry weather, low water level
	GWDrain-6		2/06/2005	slight flow (1L/min)	7.11	156	1173	786	60	9.4	slow flow
	GWDrain-6		21/10/2005		7.71	109	2394	1604	100	21.68	Enviromanagers
	GWDrain-6		21/11/2005		7.86	102	1949	1306	100	21.21	Enviromanagers
	GWDrain-6		20/12/2005		7.75	100	2131	1428	72	19.26	Enviromanagers
SW Drain	SW Drain	FC-29	27/01/2005	Shallow drain (<1m), flowing (~1L/sec), heavy vegetation, cow dung	6.48	171	256	172	10	23.3	cow dung, odour, turbid, gw seepage
	SW Drain	FC-29	2/06/2005	Shallow drain (<1m), flowing (~1L/sec), heavy vegetation, cow dung	6.83	127	312	209	47	14.7	cow dung, odour, turbid, gw seepage
	SW Drain	FC-29	3/08/2005	Shallow drain (<1m), flowing No flow, heavy vegetation, cow dung	7.11	5	340	228	70	15.3	dry weather, low drain levels- stagnant
	SW Drain	FC-29	21/10/2005		7.65	87	465	312	92	20.66	Enviromanagers
	SW Drain	FC-29	21/11/2005		7.98	80	389	261	100	20.91	Enviromanagers
	SW Drain	FC-29	20/12/2005		7.6	82	373	250	81	17.36	Enviromanagers
W Drain	W Drain	FC-28	27/01/2005	3m wide, approx 1m deep, still water	7.08	185	417	279	38	22.8	slight turbid, brown, vegetated drain
	W Drain	FC-28	2/06/2005	3m wide, approx 1m deep, still water	7.49	120	448	300	70	17.4	slight turbid, brown, vegetated drain
	W Drain	FC-28	3/08/2005	3m wide, approx 1m deep, still water	7.4	11	440	295	75	15.8	slight turbid, brown, vegetated, stagnant
	W Drain	FC-28	21/10/2005	dry							
	W Drain	FC-28	21/11/2005		8.14	79	689	462	154	19.45	Enviromanagers
	W Drain	FC-28	20/12/2005		7.56	87	539	361	59	15.56	Enviromanagers

Table 4- Field Chemistry Measurements- Surface Waters

Dredge Pond, Foys Swamp and Blue Angle Creek

Water Body	Lab Sample ID	Field Sample ID	Date	Decription	pH	Redox (mV)	EC (uS/cm)	TDS (mg/L)- #	DO (%)	Temp	Comments
NW Drain	NW Drain	FC-3	27/01/2005	3m wide, approx 1m deep, still water, heavy vegetation	4.1	188	1103	739	16	24.2	still water, vegatation in drain, slight turbid
		FC-1	27/01/2005	shallow drain, no flow	3.54	355	1114	746	26	25.3	acid waters
		FC-2	27/01/2005	deep drain, no flow	3.22	462	1642	1100	40	25.8	acid waters
	NW Drain	FC-3	27/01/2005	deep drain, no flow	3.4	463	1390	931	28	26.5	acid waters
		FC-4	27/01/2005	deep drain, no flow	3.16	470	2099	1406	30	27.3	acid waters
		FC-5	27/01/2005	shallow drain, no flow	3.33	406	4810	3223	41	30	acid waters
	NW Drain	FC-3	2/06/2005	deep drain, no flow	4.81	258	720	482	47	12.7	Heavy vegetation
		FC-4	3/08/2005	deep drain, no flow	4.82	74	1918	1285	73	13.6	dry weather, low drain levels
	NW Drain	FC-3	3/08/2005	deep drain, no flow	4.98	81	672	450	65	14.6	dry weather, low drain levels
	NW Drain	FC-3	21/10/2005		6.91	128	3214	2153	67	21.32	Enviromanagers
	NW Drain	FC-3	21/11/2005		4.11	337	2079	1393	100	22.6	Enviromanagers
	NW Drain	FC-3	20/12/2005		6.56	90	1636	1096	79	21.22	Enviromanagers
Main Drain (up stream)	MDrain-1	FC-17	24/01/2005	clear, no visible flow, >1.5m depth,5m wide.	5.73	158	781	523	35	25.3	water level ~0.5m bgl
	MDrain-1	FC-17	27/01/2005	clear, no visible flow, >1.5m depth,5m wide.	5.42	276	805	539	34	26.6	water level ~0.5m bgl
	MDrain-1	FC-17	31/01/2005	clear, no visible flow, >1.5m depth 5m wide,	5.35	130	1034	693	61	28	wet weather
	MDrain-1	FC-17	2/06/2005	clear, no visible flow, >1.5m depth,5m wide.	6.38	136	1164	780	47	12.6	water level ~0.5m bgl
	MDrain-1	FC-17	3/08/2005	clear, no visible flow, >1.5m depth,5m wide.	6.3	26	2101	1408	33	13.2	dry weather, low drain levels
	MDrain-1	FC-17	21/10/2005		7.27	97	7293	4886	62	21.55	Enviromanagers
	MDrain-1	FC-17	21/11/2005		7.28	109	2506	1679	111	21.22	Enviromanagers
	MDrain-1	FC-17	20/12/2005		7.24	115	3192	2139	77	21.41	Enviromanagers
Main Drain (dn stream)	MDrain-2	FC-32	27/01/2005	clear, no visible flow, >1.5m depth,4m wide.	6.52	222	1309	877	24	27.8	water level ~0.5m bgl
	MDrain-2	FC-32	4/02/2005	shallow drain, no flow	5.5	180	960	643	35	19.3	clear water
	MDrain-2	FC-32	2/06/2005	moderately full	7.06	166	1194	800	42	10.9	clear water, drain almost full
	MDrain-2	FC-32	3/08/2005	clear water, no visible flow, >1.5m depth,4m wide.	6.98	112	2330	1561	63	14.1	clear water. Dry weather - low level
	MDrain-2	FC-32	21/10/2005		7.34	130	6827	4574	70	22.97	Enviromanagers
	MDrain-2	FC-32	21/11/2005		6.89	28	6574	4405	125	21.41	Enviromanagers
	MDrain-2	FC-32	20/12/2005		7.43	107	3485	2335	74	23.5	Enviromanagers
Large Dam	LD-2/ M Dam	FC-30	27/01/2005	Full dam next to Beach Rd, 300 MG capacity	7.01	160	154	103	50	24.8	slight turbid, brown.
	M Dam	FC-30	2/06/2005	Full dam next to Beach Rd, 300 MG capacity	8.42	162	177	119	95	17.2	slight turbid, brown.
	LD-2/ M Dam	FC-30	3/08/2005	Full dam next to Beach Rd, 300 MG capacity	6.12	78	170	114	80	14.5	slight turbid, brown.
	M Dam	FC-30	21/10/2005		8.32	62	294	197	100	20.09	Enviromanagers
	M Dam	FC-30	21/11/2005		6.77	95	186	125	100	22.55	Enviromanagers
	M Dam	FC-30	20/12/2005		7.73	80	194	130	100	21.85	Enviromanagers
Small Dams		FC-22	24/01/2005	clear, small, vegetated, <0.7m deep	6.35	199	87	58	50	27	very shallow, no flow.
		FC-21	24/01/2005	Clear water, dam next to Beach Rd, 10 MG capacity	6.4	200	232	155	65	25.8	~0.5 mbg, 50m by 50m, 3.5m deep
		FC-24	24/01/2005	Clear water, dam downhill of large dam	6.95	170	159	107	85	26.1	~0.5 mbg, captures leakage from large dam
		FC-31	24/01/2005	Clear water, small shallow dam next to Beach Rd, vegetated	6.15	216	143	96	55	25.3	Heavy vegetation
Blue Angle Creek (dn)	BA Creek	FC-25	31/01/2005	5-10m wide, next to flood gates	4.79	275	1351	905	26	25.8	slightly turbid, brown, wet weather
	BA Creek	FC-25	3/02/2005	5-10m wide, next to flood gates- moderate flow	6.69	392	392	263	50	26	slight-mod turbid, brown- wet weather flows
	BA Creek	FC-25	2/06/2005	5-10m wide, next to flood gates- moderate flow	6.7	174	21820	14619	43	15.5	high tide
	BA Creek	FC-25	3/08/2005	5-10m wide, next to flood gates- low flow	6.58	109	6320	4234	33	16.2	Low tide, mouth open, slight turbidity

Table 4- Field Chemistry Measurements- Surface Waters

Dredge Pond, Foys Swamp and Blue Angle Creek

Water Body	Lab Sample ID	Field Sample ID	Date	Decription	pH	Redox (mV)	EC (uS/cm)	TDS (mg/L)- #	DO (%)	Temp	Comments
	BA Creek	FC-25	21/10/2005		7.28	138	9981	6687	81	22.69	Enviromanagers
	BA Creek	FC-25	21/11/2005		7.15	85	5229	3503	92	21.35	Enviromanagers
	BA Creek	FC-25	20/12/2005		7.32	85	10460	7008	73	17.48	Enviromanagers
				Min	3.03	5	87	58	10	8	
				Max	8.42	475	21820	14619	154	35	
				Average	6.24	171	2353	1577	65	22	

Notes:

E2W Field Equipment Calibrated: Field Kit 90 FLMVSA (EnviroEquip Pty Ltd)

mbgl= metres below ground level

Enviromanagers conducted sampling from September 2005 onwards

Table 5- Groundwater Field Chemical Parameters

Cleary Bros - Beach Road, Berry.

Well ID	Date	Time	SWL (m bgl)	Stick up (m)	BOH (m bgl)	Volume Purged (L)	pH	Redox (mV)	EC (uS/cm)	TDS (mg/L)- #	DO (%)	Comments
New Wells (Jan 05)												period of wet weather and boggy ground
GW-A	3/02/2005	8.19 am	0.00	0.70	2.20	50	6.02	37	140	94	30	slight turbidity, brown, rapid recovery (high K), some sw ingress
	31/01/2005	1.30pm	0.10	0.70		1	6.82	95	337	226	4	trace H2S odour (field chem only)
	8/02/2005	9.30 am	0.30	0.70								excavation area
	28/04/2005	9.30 am	0.72	0.70	2.30							no field chem (lab analyses)
	2/06/2005	9.15 am	0.24	0.70	2.30							
	3/08/2005	12.15 pm	0.58	0.70	0.92	2						insufficient sample- slow recovery when purged
	21/11/2005	1pm	0.91	0.70			6.66	-29	555	372	67.4	Enviromanagers
	20/12/2005	2pm	0.96	0.70								Enviromanagers
GW-B	3/02/2005	8.19 pm	0.00	0.77	2.20	15	4.21	143	2228	1493	49	clear water, moderate recovery, some sw ingress
	31/01/2005	2.30pm	0.00	0.77		1	4.17	302	3460	2318	15	slight turbidity, brown
	15/02/2005	2.00 pm	0.70	0.77								water level measured during dry period
	2/06/2005	11.30am	0.60	0.77								
	3/08/2005	2.20pm	0.48	0.77	1.98	2	5.31	-36	3310	2218	10	turbid, H2S odour
	21/11/2005	11am	0.63	0.77			4.27	30	2806	1880	65	Enviromanagers
	20/12/2005	2.50pm	0.63	0.77								Enviromanagers
GW-C	4/02/2005	8.30am	0.00	0.73	2.20	8	3.75	200	7540	5052	28	slightly turbid- brown, slow gw recovery
	15/02/2005	2.00 pm	0.71	0.73								water level measured during dry period
	28/04/2005	11.30am	0.49	0.73	2.20							no field chem (lab analyses)
	2/06/2005	11.40am	0.48	0.73								
	3/08/2005	2.30pm	0.58	0.73	2.58	2	5.5	-108	7690	5152	9.5	turbid, H2S odour
	21/11/2005	1.30am	0.58	0.73			4.55	28	6114	4096	56.7	Enviromanagers
	20/12/2005	3pm	0.71	0.73								Enviromanagers
GW-D	4/02/2005	9.00am	0.00	0.50	2.20	10	3.81	232	7510	5032	14	test
	15/02/2005	2.15 pm	0.77	0.50								water level measured during dry period
	2/06/2005	3.20pm	0.49	0.50								
	3/08/2005	1.40pm	0.60	0.50	2.13	2	5.81	-23	3510	2352	8	turbid water, slow recovery
	21/11/2005	11am	0.76	0.50			3.91	103	3267	2189	40.7	Enviromanagers
	20/12/2005	3.30pm	0.93	0.50								Enviromanagers
GW-E	4/02/2005	9.40am	1.40	0.71	2.03	1	4.27	193	2560	1715	30	mod turbid - brown, v slow gw recovery
	15/02/2005	3.00pm	1.41	0.71								higher ground
	2/06/2005	3.30pm	0.58	0.71								
	3/08/2005	2.00pm	0.63	0.71	1.97	2	5.62	-33	3730	2499	10	turbid water, slow recovery
	21/11/2005	11.20am	0.91	0.71			4.67	63	4126	2764	51.4	Enviromanagers
	20/12/2005	4pm	1.04	0.71								Enviromanagers
GW-F	3/08/2005	12.30pm	0.42	1.15	1.77	2	6.14	122	502	336	33.3	turbid water, slow recovery
	28/04/2005	9.30am	0.58	1.15	1.77							dry weather
	2/06/2005	10.10am	0.21	1.15								
	21/11/2005	1.10pm	0.68	1.15			6.4	5	545	365	77.3	Enviromanagers
	20/12/2005	4.30pm	0.81	1.15								Enviromanagers
GW-G	28/04/2005	9.45 am	0.62	1.15	1.32							dry weather
	2/06/2005	10am	0.18	1.15								
	3/08/2005	1.00pm	0.55	1.15	1.32	2	6.86	89	630	422	25	turbid water, slow recovery
	21/11/2005	4:48	0.77	1.15			6.98	-86	400	268	36.9	Enviromanagers
	20/12/2005	1pm	0.88	1.15								Enviromanagers
Existing Wells												
MW-2R	28/04/2005	12.30pm	0.60	0.66	1.22							dry weather
	3/08/2005	11.45am	0.70	0.66	1.22	2	NA					insufficient sample- slow recovery when purged
	21/11/2005		dry	0.66								
	20/12/2005	2pm	dry	0.66								Enviromanagers
MW-1#	3/02/2005	3.00pm	0.61	0.23	3.85	10	6.27	74	452	303	19.9	Very turbid, grey (frogs inside well)

Notes:
E2W - Field parameters (ph, EC etc) noted are at end of purging and start of sampling.
E2W Field Equipment Calibrated: Field Kit 90 FLMVSA (EnviroEquip)
SWL= standing water level
BOH= bottom of bore
mbgl= metres below ground level
TDS = EC*0.67 (approximate)

Monthly Water Monitoring Results - GW and SW.xls

ID	Parameter	Units	09/24/2003	10/27/2003	11/19/2003	12/31/2003	01/30/2004	02/26/2004	03/31/2004	04/29/2004	05/27/2004	06/28/2004	07/28/2004	08/27/2004	09/27/2004	10/27/2004	11/26/2004	12/29/2004	01/20/2005
	Cl:SO4 Ratio	mg/l			10						23						5.2		
	Conductivity	uS/cm@25 deg C	898	1113	970	615	534	489	382	460	365	323	278	396	479	430	710	780	1030
	Groundwater Level	m	0.51	0.33	-0.06	-	-	1.93	1.63	1.65	1.69	1.53	1.65	1.73	1.7	1.94	1.48	1.43	0.48
	pH	pH units	6.3	6.6	5.4	8.4	5.9	5.8	6.2	5.4	6.3	6.1	5.7	6.2	5.8	6.5	6.7	6.5	6.6
WM2																			
	Cl:SO4 Ratio	mg/l			3.3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Conductivity	uS/cm@25 deg C	466	530	465														
	Groundwater Level	m	0.29	0.17	-0.03														
	pH	pH units	7	7	7.4														
WM4																			
	Cl:SO4 Ratio	mg/l	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Conductivity	uS/cm@25 deg C																	
	Groundwater Level	m																	
	pH	pH units																	
WM5																			
	Cl:SO4 Ratio	mg/l	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Conductivity	uS/cm@25 deg C																	
	Groundwater Level	m																	
	pH	pH units																	
WM6																			
	Cl:SO4 Ratio	mg/l	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Conductivity	uS/cm@25 deg C																	
	Groundwater Level	m																	
	pH	pH units																	
WM7																			
	Cl:SO4 Ratio	mg/l			4.8						3.8						3		
	Conductivity	uS/cm@25 deg C	325	293	245	257	324	290	285	248	268	292	262	339	336	180	210	190	160
	Groundwater Level	m	-0.39	-0.31	-0.34	-0.23	-0.37	-0.41	-0.51	0.09	-0.29	-0.26	-0.28	-0.41	-0.41	0.09	-0.21	-	-0.46
	pH	pH units	5.5	5.7	5.8	6.1	5.9	5.7	5.6	6	5.8	5.6	5.6	5.4	5.2	5.8	5.4	5.5	5.7
WM9																			
	Cl:SO4 Ratio	mg/l			1.4						0.63						1.1		
	Conductivity	uS/cm@25 deg C	162	178	166	176.9	334	336	725	309	219	188	192	274	276	140	350	370	860
	Groundwater Level	m	-0.74	-0.88	-0.92	-0.75	-0.95	-0.9	-1.1	-0.45	-0.63	-0.79	-0.81	-1	-0.95	-0.79	-0.75	-0.9	-1.15
	pH	pH units	5.7	5.6	6	6.1	6.4	6.2	7	6.5	6.1	6.1	6.2	5.5	5.6	6.2	6.3	6.1	6.4
WM11																			
	Cl:SO4 Ratio	mg/l			5.8						4.4						3.6		
	Conductivity	uS/cm@25 deg C	1358	1178	798	660	561	912	NR	688	1325	804	1231	1202	2110	1540	840	970	1110
	Groundwater Level	m	-1.08	-0.88	-0.87	-1.66	-1.46	-1.38		-1.52	-1.23	-1.48	-1.46	-1.55	-1.46	-1.38	-1.38	-0.98	-1.53
	pH	pH units	5	5.3	5.1	6	5.5	5.4		5.4	5	5	4	5.1	4.9	4.8	5.9	6	6.4
WM12																			
	Cl:SO4 Ratio	mg/l			5.5						3.8						1.3		
	Conductivity	uS/cm@25 deg C	460	464	434	2700	3080	312	347	240	254	373	612	695	961	640	600	620	430
	Groundwater Level	m	-0.17	-0.08	0.03	-0.4	-0.45	-0.45	-0.45	-0.18	-0.13	-0.25	-0.3	-0.29	-0.25	0.14	-0.2	-0.2	-0.4
	pH	pH units	6.2	7	6.2	6	6.4	6.1	6.2	6.1	6.2	4.3	3.4	3.9	3.3	6.2	3.9	5.4	5.4
WM14																			
	Cl:SO4 Ratio	mg/l	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Conductivity	uS/cm@25 deg C																	
	Groundwater Level	m																	
	pH	pH units																	
Ex Works																			
	Cl:SO4 Ratio	mg/l			0.84						NR						0.71		
	Conductivity	uS/cm@25 deg C	1339	615	557	615	654	655	660	603		524	545	779	902	510	530	530	560
	Groundwater Level	m	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-
	pH	pH units	8.1	8.1	7.5	8.4	8.4	7.5	7.8	7.5		7.4	7.2	7.3	7.6	7.8	7.5	7.4	7.8
Blue Angle Creek																			
	Cl:SO4 Ratio	mg/l			6.3						6.4						5.8		
	Conductivity	uS/cm@25 deg C	3670	3910	3980	10830	10830	1538	24600	5660	4520	14950	7890	16540	36400	750	10010	20400	20000
	Groundwater Level	m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	pH	pH units	6.8	6.7	7.1	7.1	7.2	6.4	6.7	6.6	5.9	6.8	6.3	6.4	6.6	3.5	7	6.9	6.9
South Reed																			
	Cl:SO4 Ratio	mg/l	NR	NR	0.86	NR	NR	NR	NR	NR	NR								
	Conductivity	uS/cm@25 deg C			558														
	Groundwater Level	m			-														
	pH	pH units			7.5														

Davron Engineering Pty Ltd

Ref:123r61gerwm.wk4

CLEARY BROS(BOMBO) PTY LTD
SOUTHERN EXTRACTION AREA, GERROA
GROUNDWATER MONITORING

LOCATION	AHD	DATE 28-Jan-93 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 02-Mar-93 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 26-Mar-93 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 28-Apr-93 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 03-Jun-93 WATER LEVEL	CONDUCTIVITY	pH	REMARKS
SOUTHERN EXTRAC AREA																					
WM1	2.83	0.60					400uS			0.30	626uS	7.8						0.10	970uS	8.8	
WM2	5.86	2.03				1.63	5.98mS	6.0		1.76	638uS	6.0		1.68	780uS	6.3		1.20	1066uS	7.9	
		1.11				0.56	0.92mS	6.0		0.91	436uS	6.8		0.81	492uS	7.1		0.71	466uS	7.7	
WM3	1.47	0.22							very dirty/ strong												
WM4	5.57	0.37				0.07	47mS	7.0	smell	0.19	317uS	6.9		0.02	377uS	7.0		0.07	243uS	7.5	
						0.22	463uS	7.0		0.22	412uS	7.7		0.00	407uS	7.8		0.12	408uS	7.9	
WM5	4.53	0.33											very								
WM6	4.78	0.13				0.18	166uS	7.0		0.16	126uS	8.2	murky	0.11	134uS	7.9		0.13	134uS	8.1	
						0.03	181uS	7.0		0.03	186uS	7.4		-0.03	226uS	7.7		-0.02	122uS	7.8	
BLUE ANGLE PIT																					
WM7	1.69	0.64							strong												
WM8	2.34	0.37				0.29	556uS	6.0	smell	0.29	166uS	6.1		0.17	131uS	6.1		0.09	151uS	6.8	
WM9	2.00	0.56				0.09	-			0.25				-0.06				-0.16			
WM10	2.34	0.14				0.26	283uS	6.0		0.28	180uS	6.8		0.04	183uS	6.9		0.00	165uS	6.7	
WM11	0.92	-0.38				0.01	191uS	6.0		-0.01	129uS	6.6		-0.11	166uS	6.9		-0.11	213uS	6.7	
BLUE ANGLE CREEK						(-0.33)	1.24mS	6.0		(-0.18)	236uS	6.1		(-0.48)	320uS	6.3		(-0.28)	336uS	6.0	
							32.2mS		low tide		8.36mS				32.3mS				26.8mS		
BAILEY'S ISLE																					
WM12	3.40	0.00				0.15	5.26mS	7.0		-0.05	2.69mS			-0.20	3.06mS	6.8		-0.15	1814uS	6.7	
WM13	6.10	0.15				0.00	1.17mS	7.0		-0.05	1130uS	7.6		-0.08	1.66mS	7.6		-0.05	1210uS	7.5	
WM14	2.44	0.64				0.34	460mS	7.0		0.25	330uS	6.5		0.14	364uS	6.9		0.04	746uS	6.3	
BLUE ANGLE CREEK							38.8mS				24.6mS				39.2mS				29.5mS		

Table B.2 - 1

Ref:123rS\gerwm.wk4

CLEARY BROS(BOMBO) PTY LTD
SOUTHERN EXTRACTION AREA, GERROA
GROUNDWATER MONITORING

LOCATION	AHD	DATE	30-Jul-93				DATE	03-Sep-93				DATE	07-Oct-93				DATE	24-Nov-93				DATE	04-Mar-94			
			WATER LEVEL	CONDUCTIVITY	pH	REMARKS	WATER LEVEL	CONDUCTIVITY	pH	REMARKS	WATER LEVEL	CONDUCTIVITY	pH	REMARKS	WATER LEVEL	CONDUCTIVITY	pH	REMARKS	WATER LEVEL	CONDUCTIVITY	pH	REMARKS
SOUTHERN EXTRAC. AREA																										
LOCATION	AHD		0.00					614uS	8.9			482uS	8.2			561uS	9.0			800uS	8.7					
WM1	2.83		1.23	1688uS	7.5		0.78	730uS	7.9		1.88	1230uS	7.7		1.69	1066uS	7.7		1.11	1640uS	8.1					
WM2	5.86		0.61	440uS	7.7		0.56			no access	0.91	410uS	7.9		0.36	448uS	7.8		0.47	740uS	8.0					
WM3	1.47		0.07	266uS	7.5		0.20	209uS	8.2		0.37	180uS	7.3		0.14	130uS	7.5		0.13	291uS	7.6					
WM4	5.57		0.37	466uS	8.0		0.60	617uS	7.8		0.60	490uS	7.5		0.32	606uS	7.5		0.12	550uS	7.5					
WM5	4.53		0.38	202uS	8.2		0.38	125uS	8.5		0.48	126uS	8.1		0.29	128uS	8.3		0.11	262uS	7.5					
WM6	4.78		0.28	146uS	8.0		0.38	136uS	8.2		0.28	91uS	8.3		0.11	142uS	8.0		-0.03	220uS	7.9					
BLUE ANGLE PIT																										
LOCATION	AHD																									
WM7	1.89					rain	0.34	485uS	7.8		0.69	155uS	7.4		0.42	228uS	7.1		0.14	1634uS	7.7					
WM8	2.34					rain	-0.02				0.49				0.22				-0.09							
WM9	2.00					rain	0.35	193uS	6.2		0.70	211uS	7.1		0.42	207uS	7.3		0.26	462uS	7.2					
WM10	2.34					rain	0.26	128uS	6.4		0.29	161uS	7.1		0.07	162uS	7.1		-0.11	403uS	7.5					
WM11	0.92					rain	(0.34)	182uS	6.7		(-0.09)	166uS	7.2		(-0.33)	473uS	6.6		(-0.39)	782uS	6.7					
BLUE ANGLE CREEK						rain		22.2mS				7.04mS				17.2mS	6.2			37.7mS	7.4					
BAILEY'S ISLE																										
WM12	3.40					rain	0.41	1.36mS	7.0		0.13	533uS	7.4		-0.07	2.28mS	7.4		-0.14	433uS	7.1					
WM13	6.10					rain	0.46	773uS	7.6		0.38	597uS	7.6		0.06	876uS	7.6		-0.03	1063uS	7.3					
WM14	2.44					rain	0.27	248uS	7.8		0.77	264uS	7.4		0.70	480uS	7.6		0.16	322uS	7.2					
BLUE ANGLE CREEK						rain		13.9mS																		

Ref:123r6gerwm.wk4

CLEARY BROS(BOMBO) PTY LTD
SOUTHERN EXTRACTION AREA, GERROA
GROUNDWATER MONITORING

LOCATION	AHD	DATE 07-Apr-94 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 04-May-94 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 03-Jun-94 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 07-Jul-94 WATER LEVEL	CONDUCTIVITY	pH	REMARKS	DATE 18-Aug-94 WATER LEVEL	CONDUCTIVITY	pH	REMARKS
SOUTHERN EXTRAC AREA																					
LOCATION	AHD																				
WM1	2.83	1.42	566uS	8.6			895uS	8.6			640uS	8.0			520uS	8.1			496uS	7.3	
WM2	5.86	0.79	777uS	8.1		1.56	460uS	8.6		1.60	350uS	8.0		2.07	422uS	7.7		1.60	436uS	6.1	
			633uS	7.7		0.98	395uS	8.2		0.94	433uS	7.8		0.99	716uS	7.6		0.79	776uS	7.9	
WM3	1.47	0.27	1.833mS	8.1		0.35	1.28mS	8.4		0.20	161uS	8.1		0.31	168uS	8.1		0.10	132uS	6.9	
WM4	5.57	0.67	930uS	7.3		0.64	802uS	7.6		0.44	480uS	7.6		0.39	640uS	7.2		0.26	409uS	7.2	
WM5	4.53	0.62	211uS	8.2		0.69	1.14mS	8.4		0.73	111uS	8.4		0.43	96uS	8.3		0.03	86uS	6.2	
WM6	4.78	0.16	1.163mS	7.6		0.33	1.1mS	8.2		0.19	88uS	7.8		0.20	113uS	8.2		0.08	96uS	6.6	
BLUE ANGLE PIT																					
LOCATION	AHD																				
WM7	1.69	0.55	361uS	7.2		0.74	187uS	7.2		0.56	166uS	7.8		0.62	164uS	7.3		0.39	161uS	6.7	
WM8	2.34	0.33				0.60				0.31				0.48				0.14			
WM9	2.00	0.67	217uS	7.1		0.70	234uS	7.4		0.62	178uS	7.4		0.61	163uS	7.3		0.32	174uS	6.3	
WM10	2.34	0.36	239uS	7.3		0.34	239uS	7.7		0.18	178uS	7.2					no access				
WM11	0.92	(0.28)	436uS	6.5		(-0.17)	360uS	7.1		(-0.32)	367uS	6.1		(0.27)	510uS	6.3		(0.02)	573uS	6.2	
BLUE ANGLE CREEK			19.6mS	6.8			6.96mS	6.7			16.3mS	6.0			6.83mS	6.3			46mS	6.0	
BAILEY S ISLE																					
WM12	3.40	0.45	604uS	7.6		0.22	448uS	7.8		0.01	502uS	7.3		0.02	446uS	6.9		0.02	663uS	5.6	
WM13	6.10	0.60	728uS	7.0		0.47	667uS	7.4		0.26	563uS	6.8		0.14	503uS	6.7		0.10	618uS	7.0	
WM14	2.44	0.67	667uS	6.7		0.81	224uS	7.3		0.67	258uS	7.7		0.64	220uS	7.6		0.33	210uS	7.0	
BLUE ANGLE CREEK																					

Davron Engineering Pty Ltd

Ref:123r5\gerwin.wk4

CLEARY BROS(BOMBO) PTY LTD
SOUTHERN EXTRACTION AREA, GERROA
GROUNDWATER MONITORING

LOCATION		DATE	21-Sep-94			DATE	13-Oct-94			DATE	26-Oct-94		
		WATER LEVEL	CONDUCTIVITY	pH	REMARKS	WATER LEVEL	CONDUCTIVITY	pH	REMARKS	WATER LEVEL	CONDUCTIVITY	pH	REMARKS
SOUTHERN EXTRAC. AREA													
LOCATION	AHD		506uS	7.5			590uS	8.1			607uS	8.0	
WM1	2.83	1.21	1330uS	6.8		0.95	1600uS	6.7		0.92	1760uS	6.7	
WM2	5.86	0.70	1162uS	6.8		0.67	670uS	7.1		0.66	956uS	7.7	
WM3	1.47	0.01	168uS	6.4		-0.08	262uS	6.6		0.03	142uS	6.4	
WM4	5.57	0.14	420uS	7.0		0.14	406uS	6.8		0.15	377uS	6.7	
WM5	4.53	0.21	104uS	7.3		0.16	137uS	7.0		0.17	136uS	7.5	
WM6	4.78	0.06	98uS	7.1		-0.05	127uS	6.7		0.05	884uS	6.8	
BLUE ANGLE PIT													
LOCATION	AHD												
WM7	1.69	0.27	326uS	6.3		0.15	553uS	6.3		0.16	425uS	6.6	
WM8	2.34	0.04				-0.05				-0.12			
WM9	2.00	0.12	206uS	6.9		0.07	226uS	6.4		0.10	214uS	6.7	
WM10	2.34												
WM11	0.92	(0.27)	463uS	6.7		(0.13)	367uS	6.2		(0.17)	388uS	6.1	
BLUE ANGLE CREEK			46mS	6.4			48.9mS	6.6			40.1mS	6.6	
BAILEY SISE													
WM12	3.40	0.21	2.4mS	6.3		0.13	3.29mS	6.6		0.18	2.6mS	6.0	
WM13	6.10	0.29	900uS	6.4		0.27	925uS	7.0		0.31	860uS	6.8	
WM14	2.44	0.14	288uS	6.1		0.07	382uS	6.9		0.06	266uS	6.2	
BLUE ANGLE CREEK													

Table B.2 - 4

GROUNDWATER LEVELS & pH READINGS 12/1994 - 11/1/96

Date	SOUTHERN EXTRACTION AREA																		BLUE ANGLE PIT															BAILEY'S ISLAND								
	WM1			WM2			WM3			WM4			WM5			WM6			WM7			WM8			WM9			WM10			WM11			WM12			WM13			WM14		
	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH
04/03/94	1.11	1540	8.1	0.47	740	8.0	0.1	291	7.6	0.12	550	7.5	0.11	252	7.5	-0.03	220	7.9	0.14	1534	7.7	-0.09	-	-	0.25	462	7.2	-0.11	403	7.5	-0.39	782	6.7	-0.14	433	7.1	-0.03	1053	7.3	0.16	322	7.2
07/04/94	1.42	777	8.1	0.79	633	7.7	0.27	1.933	8.1	0.57	930	7.3	0.615	211	8.2	0.16	1.163	7.9	0.55	361	7.2	0.33	-	-	0.57	217	7.1	0.36	239	7.3	0.29	435	6.5	0.45	604	7.6	0.6	728	7.0	0.67	567	6.7
04/05/94	1.56	460	8.6	0.98	385	8.2	0.35	128	8.4	0.64	802	7.5	0.59	1.14	9.4	0.33	1.1	9.2	0.74	187	7.2	0.5	-	-	0.7	234	7.4	0.34	239	7.7	-0.17	350	7.1	0.22	448	7.8	0.47	557	7.4	0.81	224	7.3
03/06/94	1.5	890	8.0	0.94	433	7.8	0.2	161	8.1	0.44	480	7.6	0.73	111	9.4	0.19	88	7.8	0.56	156	7.8	0.31	-	-	0.52	178	7.4	0.18	178	7.2	-0.32	367	6.1	0.01	502	7.3	0.25	563	6.9	0.57	258	7.7
07/07/94	2.07	432	7.7	0.99	716	7.5	0.31	168	8.1	0.39	540	7.2	0.43	96	9.3	0.20	113	9.2	0.62	164	7.3	0.48	-	-	0.61	153	7.3	-	-	-	-0.27	510	5.3	0.02	446	6.9	0.14	503	6.7	0.64	220	7.6
18/08/94	1.5	435	6.12	0.79	775	7.85	0.10	132	5.88	0.25	409	7.17	0.03	86	5.69	0.08	96	6.51	0.39	161	5.68	0.41	-	-	0.32	174	5.33	-	-	-	0.02	573	5.2	0.02	663	5.59	0.1	618	7.0	0.33	210	7.0
21/09/94	1.21	1330	5.8	0.7	1163	6.8	0.01	159	6.4	0.14	420	7.0	0.21	104	7.3	0.06	98	7.1	0.27	326	6.3	0.04	-	-	0.12	205	5.9	-	-	-	0.27	463	5.7	-	46	5.4	0.29	900	6.4	0.14	388	6.1
13/10/94	0.95	1600	6.7	0.57	670	7.1	-0.09	252	6.6	0.14	405	6.8	0.16	137	7.0	-0.05	127	6.7	0.15	553	6.3	-0.05	-	-	0.07	226	6.4	-	-	-	0.13	367	5.2	0.13	3.29	6.5	0.27	925	7.0	0.07	382	6.9
25/10/94	0.92	1760	6.7	0.56	995	7.1	0.03	142	6.4	0.15	377	6.7	0.17	135	7.5	0.05	88.4	6.8	0.16	425	6.6	-0.12	-	-	0.1	214	5.7	-	-	-	0.17	388	5.1	0.18	2.5	6.0	0.31	860	6.8	0.06	256	6.2
05/12/94	0.71	2.94	6.4	0.41	690	8.7	-0.16	946	6.7	0.07	457	7.2	0.1	184	7.5	-0.03	108	7.5	0.05	593	7.2	-0.24	-	-	-0.01	344	6.6	-	-	-	0.07	530	6.4	0.08	2.6	7.4	0.21	1200	7.7	-0.03	280	6.9
10/01/95	0.80	1931	6.7	0.34	712	6.3	-0.06	277	6.7	0.09	566	6.9	0.15	176	7.0	0.05	121	6.7	0.12	698	7.1	-0.19	-	-	0.22	354	6.6	-	-	-	0.17	1029	4.8	0.16	7.74	6.2	-	-	-	-	-	-
09/02/95	0.97	2.18	6.5	0.29	1983	6.5	-0.91	163	6.3	0.15	388	7.1	0.2	162	6.5	0.08	133	6.7	0.17	532	7.01	-0.21	-	-	0.54	257	6.3	-	-	-	-0.04	917	5.8	0.1	2.26	7.1	0.22	2.17	7.2	0.11	411	6.5
28/02/95	0.75	2.66	6.5	0.26	530	7.0	-0.16	178	6.5	0.09	1620	7.3	0.15	490	6.9	0.06	143	7.0	0.07	624	6.9	-0.21	-	-	-0.01	303	6.6	-	-	-	-0.08	1552	6.2	0.03	2.4	7.1	0.16	1074	7.4	0.01	354	6.9
06/04/95	0.80	1530	6.1	0.23	770	6.3	-0.03	140	7.0	0.2	990	7.0	0.29	185	7.5	0.22	88	7.4	0.31	475	6.5	-0.05	-	-	0.4	247	6.7	-	-	-	0.39	3.44	5.8	0.47	1.9	6.9	0.5	0.79	7.2	0.16	0.21	7.0
03/05/95	0.51	1225	6.4	0.19	625	6.5	-0.18	173	7.1	-0.33	570	6.8	0.16	174	7.3	0.06	76	6.7	0.18	189	6.2	-0.56	-	-	0.13	226	5.9	-	-	-	-0.03	6.04	5.2	0.05	3.19	6.7	0.21	996	7.0	0.6	432	7.0
30/05/95	1.03	650	6.3	0.45	763	6.3	0.28	207	6.7	0.42	528	6.5	0.48	141	6.8	0.30	92	6.9	0.66	139	6.3	0.44	-	-	0.65	203	5.9	-	-	-	-0.1	213	4.9	0.31	571	5.4	0.47	641	5.9	0.71	270	6.2
05/07/95	0.65	1270	6.5	0.47	720	6.2	0.17	276	6.9	0.34	582	6.6	0.32	132	7.3	0.15	209	6.7	0.58	195	6.5	0.35	-	-	0.53	205	6.1	-	-	-	-0.17	867	5.1	0.08	1483	6.2	0.25	723	6.5	0.55	330	6.6
03/08/95	1.05	1620	6.8	0.43	783	7.1	0.04	295	7.1	0.27	530	7.2	0.25	153	7.7	0.10	167	7.5	0.43	249	6.5	-0.17	-	-	0.31	309	5.7	-	-	-	-0.2	540	5.0	-0.02	2.26	6.7	0.19	918	6.9	0.35	380	7.1
05/09/95	1.03	1920	6.0	0.31	790	6.1	0.07	260	6.3	0.17	460	6.4	0.16	155	6.9	0.03	158	6.7	0.36	320	6.5	-	-	-	0.25	250	6.4	-	-	-	-0.2	215	5.6	-0.08	2.37	6.7	0.06	840	6.8	0.19	404	7.0
06/10/95	1.48	989	6.5	0.61	322	6.5	0.57	169	6.8	0.42	395	7.0	0.33	122	6.8	0.25	142	5.9	0.68	191	5.4	0.49	-	-	0.77	217	5.9	-	-	-	-0.08	910	4.5	0.32	670	5.5	0.22	630	6.4	0.77	305	6.2
02/11/95	1.58	2.17	6.3	0.82	370	6.4	0.37	300	6.7	0.57	560	6.9	0.4	113	6.5	0.3	168	6.5	0.82	195	5.8	-	-	-	0.35	231	5.2	-	-	-	-0.25	462	4.6	0.13	743	5.7	0.27	664	6.8	0.72	362	5.3
30/11/95	1.35	2.3	6.2	0.98	706	5.5	0.37	380	7.1	0.52	560	7.0	0.51	96	6.9	0.28	99	6.7	0.96	108	6.0	0.42	-	-	0.78	189	5.7	-	-	-	-0.28	471	4.3	0.18	351	5.7	0.21	619	6.9	0.88	347	6.0
21/12/95	1.57	2.44	6.5	0.28	825	6.0	0.24	320	7.3	0.48	464	7.0	0.41	103	6.8	0.19	87	6.9	0.7	258	6.1	-	-	-	-	186	5.9	-	-	-	0.08	638	4.4	0.05	2.06	6	0.18	796	6.7	0.62	33	6.0
01/02/96	2.10	1830	7.3	0.91	610	6.2	0.23	296	7.1	0.36	463	6.7	0.3	120	6.6	0.1	91	6.3	0.53	218	5.8	-	-	-	0.5	295	6.0	-	-	-	-0.22	558	4.4	-0.07	1311	6.1	0.04	729	6.4	0.44	430	6.2
15/03/96	1.35	3.17	7.1	0.76	1114	5.8	0.08	417	7.1	0.24	497	6.6	0.2	-	-	0.01	-	-	0.26	225	6.4	-	-	-	0.21	810	7.3	-	-	-	-0.35	428	5.7	0.25	1643	6.8	-0.06	897	6.7	0.14	697	6.5
04/04/96	1.14	3.91	7.2	0.35	933	5.9	-0.05	372	7.2	0.16	514	7.2	0.2	-	-	-0.07	-	-	0.15	293	7.1	-	-	-	0.02	305	6.8	-	-	-	-0.03	430	5.4	-0.17	2.77	6.6	-0.07	952	6.8	0.02	670	6.5
08/05/96	1.00	414	5.2	0.62	711	5.6	0.38	213	6.8	0.17	496	6.3	0.18	-	-	-0.02	-	-	0.31	225	6.3	-	-	-	0.43	126	6.1	-	-	-	-0.22	1215	3.9	-0.11	641	6.1	-0.01	722	6.4	0.05	330	5.5
07/06/96	1.15	3.6	6.5	0.57	723	6.0	0.08	609	7.4	0.17	590	7.3	0.18	-	-	-0.02	-	-	0.19	275	7.1	-	-	-	0.1	156	7.0	-	-	-	-0.28	500	5.6	0	1.38	6.7	0	940	6.9	0.04	433	6.5
01/07/96	1.28	630	6.4	0.51	353	6.6	0.14	273	7.5	0.17	635	7.2	0.15	-	-	-0.04	-	-	0.25	224	6.2	-	-	-	0.2	380	6.7	-	-	-	-0.27	781	3.5	-0.08	1.23	6.2	-0.01	1.08	6.8	0.09	852	6.6

GROUNDWATER LEVELS & pH READINGS 12/1994 - 11/1/96

	SOUTHERN EXTRACTION AREA																		BLUE ANGLE PIT															BAILEY'S ISLAND								
Date	WM1			WM2			WM3			WM4			WM5			WM6			WM7			WM8			WM9			WM10			WM11			WM12			WM13			WM14		
	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH
05/08/96	1.35	311	6.0	0.47	410	5.5	0.14	247	6.6	0.2	446	6.7	0.13	-	-	0.25	-	-	0.29	185	6.5	-	-	-	-0.03	147	6.0	-	-	-	-0.13	1307	3.5	-0.04	1426	5.5	0.1	708	6.2	0.07	330	6.7
04/09/96	1.40	4.62	5.6	0.69	321	5.9	0.47	370	6.7	0.3	570	6.7	0.45	98	7.5	-0.4	136	7.2	0.58	215	6.2	-	-	-	0.6	169	5.6	-	-	-	0.01	1901	3.1	0.25	691	48	0.07	880	5.7	0.44	476	6.1
30/09/96	1.65	4.11	6.0	0.64	335	6.0	0.26	290	7.0	0.3	497	6.8	0.25	-	7.0	0.1	-	6.8	0.45	187	5.5	-	-	-	0.38	116	5.3	-	-	-	0.1	615	3.6	0	1370	5.8	0.22	712	6.6	0.28	388	4.0
08/11/96	1.23	3.74	6.2	0.51	375	6.1	0.27	385	6.8	0.18	484	7.0	-	-	-	-	-	-	0.38	191	6.4	-	-	-	0.40	144	5.5	-	-	-	-0.13	735	3.9	-0.15	1536	6.2	-0.05	740	6.9	0.14	387	6.3
03/12/96	1.28	4.03	6.9	0.41	409	6.1	0.02	342	6.9	-0.15	376	7	0.2	-	-	-0.04	-	-	0.24	161	6.5	-	-	-	0.15	90	5.8	-	-	-	-0.33	660	4.2	-0.15	1840	6.1	-0.03	727	6.6	0.06	343	5.9

W.L - Water Level
CD - Conductivity

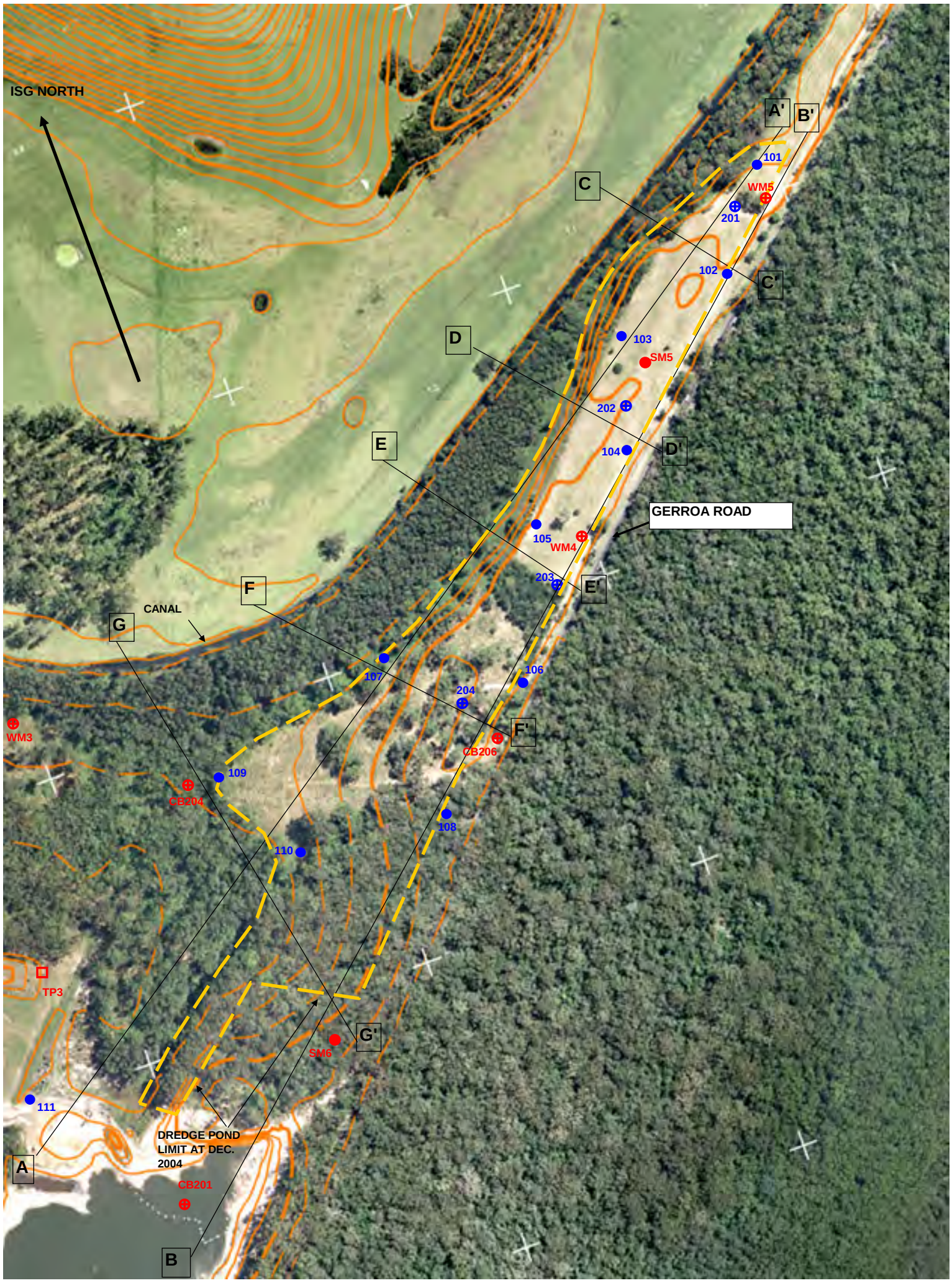
GROUNDWATER LEVELS - CONDUCTIVITY - pH READINGS 12/1990 to 12/1998

	SOUTHERN EXTRACTION AREA																		BLUE ANGLE PIT															BAILEY'S ISLAND								
Date	WM1			WM2			WM3			WM4			WM5			WM6			WM7			WM8			WM9			WM10			WM11			WM12			WM13			WM14		
	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH	W.L	CD	pH
03/12/96	1.28	4.03	6.9	0.47	409	6.1	0.02	342	6.9	-0.15	376	7	0.2			-0.04			0.24	161	6.5				0.15	90	5.8				-0.33	660	4.2	-0.15	1840	6.1	-0.03	727	6.6	0.06	343	5.9
06/01/97	1.13	4.2	6.3	0.34	342	5.8	-0.16	322	6.8	0.06	384	6.8	0.18			-0.05			0.07	191	6				-0.08	120	5.5				-0.35	789	4.1	-0.28	1636	6.2	-0.13	805	6.2	-0.07	408	6
06/02/97	1.06	2.39	6.5	0.53	372	6	0.35	284	7.1	0.35	379	6.9	0.43	148	6.6	0.27	80.2	6.6	0.54	137	6.1				0.6	102	5.7				-0.02	930	3.2	0.2	920	6	0.15	756	6	0.54	372	5.6
05/03/97	1.41	2.69	7	0.76	336	5.5	0.67	256	7	0.53	507	6.7	0.53	152	6.3	0.41	77	6.1	0.88	158	5.9				0.78	90	6				0.11	391	4.2	0.3	246	5.8	0.25	544	6.2	0.93	381	5.8
11/04/97	1.26	4.17	7.3	0.75	352	6	0.18	385	7.6	0.45	677	7.2	0.38	163	7.2	0.18	100	6.6	0.56	168	6.5				0.48	95	6.2				0.13	1320	3.73	0.02	1213	5.9	0.18	660	6.5	0.44	454	6.1
07/05/97	1.08	4.98	6.8	0.64	497	6.1	0.08	420	7.3	0.32	516	7.3	0.24			0.09			0.37	162	5.5				0.31	101	5.9				-0.17	556	5.4	-0.15	1.92	6.4	0	737	6.5	0.22	463	6.2
04/06/97	1.13	4.7	6.4	0.66	357	5.2	0.21	407	5.8	0.34	555	6.9	0.32	180	6.9	0.19			0.47	195	6.4				0.44	165	6.5				0.03	490	6.4	0.16	201	6	0.2	2.02	6.9	0.34	586	6.3
01/07/97	1.48	3.93	6	0.85	409	6	0.79	224	6.7	0.51	440	6.6	0.65	110	7	0.59	94	6.9	0.87	186	6.3				0.85	137	6.3				0.5	1347	5.8	0.58	280	5.7	0.4	562	6.2	0.99	369	5.6
04/08/97	1.68	4.79	6	0.93	501	6	0.1	533	6.8	0.51	538	6.6	0.27	128	7.5	0.23	73	7.4	0.74	166	6.1				0.6	125	6.7				-0.13	9.92	3.8	0.05	1.09	5.9	0.28	648	6.2	0.34	409	4.1
12/09/97	1.38	3.3	6.2	0.79	440	6.3	0.2	233	6.7	0.49	428	6.8	0.25			0.1			0.51	131	6.2				0.45	160	5.6				-0.37	2.6	3.8	-0.14	1153	6.3	0.03	579	6.4	0.37	525	4.5
13/10/97	1.93	4.45	6.2	0.91	428	7	0.41	214	7.2	0.49	440	6.7	0.43	109	7.5	0.23	120	7.4	0.7	172	6				0.62	139	6.2				-0.21	1.9	4.6	0.05	633	5.8	0.12	573	6.2	0.6	448	6.2
10/11/97	1.58	4.34	5.8	0.77	394	6	0.13	248	6.6	0.33	508	6.6	0.3			0.08			0.46	162	6.5				0.39	148	6.1				-0.25	3.3	4.1	-0.15	1.03	6.5	0	555	6.6	0.34	639	6.5
05/12/97	1.38	4.56	5.7	0.63	347	5.5	-0.01	304	6.9	0.23	351	7							0.39	168	7				0.18	249	6.2				-0.22	1078	5.1	-0.21	810	6.6	-0.03	5.23	6.7	0.19	906	6.4
12/01/98	0.61	5	5.7	0.46	366	6	-0.07	213	7.2	0.11	448	6.8	0.28			0.01			0.09	199	7.2				-0.66	507	7.1				-0.22	956	4.9	-0.29	955	6.7	-0.1			-0.07		
05/02/98	0.47	4.82	5.6	0.33	398	5.8	-0.17	203	6.8	0.05	909	6.6							0.01	177	6.6				-0.11	287	6.2				-0.33	8.36	5.8	-0.29	1880	7.1	-0.1	855	6.8	-0.05		
13/03/98	0.08	5.17	5.8	0.01	493	6.5	-0.31	238	7.1	-0.03			0.28			0.03			0.03	225	6.2				0.1	230	5.8				0.47	2.56	5.2	0.13	1.4	6	0.1	757	6.5	-0.12		
03/04/98	0.1	6.47	6.3	0.11	558	7.4	-0.35	291	7.3	-0.06			0.33			0.03			0.07	189	6.5				0.01	325	6.5				0.38	4.51	6.5	0.31	463	6.4	0.4	790	6.5	-0.02		
01/05/98	-0.12	6.27	5.8	0.21	536	5.8	-0.03	701	7	0.07	1052	6.6	0.33			-0.02			0.19	215	7.4				0.34	216	8.1				0.37	5.6	7	0.41	787	7.2	0.44	804	6.9	0		
01/06/98	0.5	1.22	6.1	0.41	488	6.8	0.17	240	6.5	0.32	910	7.2	-0.05			-0.07			0.48	164	7				0.54	105	6.7				-0.23	1.61	4.8	0.18	540	6	0.36	611	6.9	0.54	571	6.2
02/07/98	0.9	1.57	6.5	0.52	466	7.2	0.33	298	6.8	0.39	790	6.7	0.41	195	7.2	0.23	54	7	0.6	136	6				0.64	274	3.8				-0.19	940	3.9	0.22	580	6.5	0.32	743	6.4	0.72	941	5.8
03/08/98	1.28	2.65	6.7	0.61	478	7.7	0.33	316	7.5	0.43	614	7.2	0.36			0.18			0.61	250	6.8				0.61	1082	3.4				-0.23	2.9	4.1	0.1	387	4.4	0.2	625	6.05	0.67	615	5.6
02/09/98	2.02	2.8	5.8	1.81	528	6	0.81	229	6.5	1.87	480	6.5	1.63	93	6.9	1.03	74	6.8	1.44	209	6				1.25	400	5				-0.13	1680	4.6	0.56	430	5.2	1.32	300	5.7	1.6	472	5.4
01/10/98	1.88	3.54	5.7	1.63	531	5.7	0.63	191	6.5	1.38	870	6.3	1.13	145	7.4	0.73	78	7.1	1.09	202	6.4				1	809	5.4				-0.35	3.17	4.2	0.07	372	5	0.5	395	5.9	1.29	818	5.4
11/11/98	1.28	3.59	5.9	1.34	515	5.9	-0.53	204	6.8	0.9	1051	6.8	0.73	236	7	0.43	106	7.5	0.59	211	6.5				0.6	711	6.3				0.67	2.31	5.4	-0.06	640	6.5	0.2	617	6.5	0.78	510	6.7
21/12/98	1.46	2.9	6.1	1.21	902	7.1	0.49	216	6.9	0.69	370	6.2	0.51	171	6.7	0.29	106	6.8	0.51	200	6.3				0.51	661	0.59				0.15	1990	5.1	-0.13	1156	7.1	0.03	757	6.7	0.54	622	6.5

Piezometer Water Monitoring - Dec.98 too Nov. 00

	Southern Extraction Area																		Blue Angle Pit									Bailey's Island								
DATE	WM-1			WM-2			WM-3			WM-4			WM-5			WM-6			WM-7			WM-9			WM-11			WM-12			WM-13			WM-14		
	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph	W.L.	CD	ph
DEC. '98	1.46	2900	6.1	1.21	902	7.1	0.49	216	6.9	0.69	370	6.2	0.51	171	6.7	0.29	106	6.8	0.51	200	6.3	0.51	661	5.9	0.15	1990	5.1	-0.13	1156	7.1	0.03	757	6.7	0.54	622	6.5
JAN. '99	1.1	3320	5.5	1.12	879	6	0.24	314	6	0.6	1098	6.4	0.43			0.2	163	7.2	0.35	263	6.4	0.37	1200	6.2	-0.04	2900	6	-0.15	1442	6.8	0.03	725	7	0.38	530	6.6
FEB. '99				1.32	455	6.9	0.66	167	6.8	0.89	714	6.6	0.75	191	6.5	0.46			0.84	206	6.8	0.78	522	6.2	-0.43	2600	6	0.25	171	6.4	0.3	522	6	0.91	488	6.7
MARCH '99	1.53	1483	6.5	1.28	509	6.7	0.47	166	6.4	0.73	559	6.3	0.58	115	7	0.33	106	6.7	0.69	152	6.5	0.66	1245	6.9	-0.45	1285	6.7	-0.05	572	6.9	0.17	646	6.8	0.74	531	6.7
APRIL '99	1.61	1067	6.6	1.21	498	6.8	0.49	161	7	0.59	636	6.8	0.43	182	7.3	0.23	83	7	0.59	76	6.9	0.56	889	6.6	-0.37	1310	5.5	-0.1	535	6.7	0.04	734	6.7	0.58	421	6.5
MAY '99	1.83	1112	6.5	1.31	530	6.7	0.85	214	6.3	0.83	690	6.7	0.83	87	7.7	0.72	129	7	0.89	332	5.8	0.86	1511	6.1	-0.08	327	7.1	0.47	285	6.5	0.31	699	6.6	1.08	342	6.5
JUNE '99	1.83	1419	6.8	1.22	593	6.3	0.59	193	6.7	0.72	738	6.7	0.55	102	7.1	0.32	238	7.1	0.72	311	6.3	0.66	2150	5.8	-0.18	1302	5.5	0.01	1003	6.1	0.13	638	6.2	0.71	357	6.3
JULY '99	2.3	1416	6.3	1.43	543	6	0.94	263	6.3	1.01	432	6.8	0.95	124	6.7	0.64			1.01	302	5.7	0.87	1554	5.1	-0.23	311	5.4	0.46	459	5.3	0.6	560	6.1	0.6	222	6.2
AUG. '99																																				
SEP. '99	1.84	1600	6.1	1.08	768	5.5	0.37	288	6.4	0.62	264	6.4	1.5	126	7	0.57	102	6.2	0.43	176	6	0.55	1484	4.7	-0.04	3300	5.4	-0.09	808	5.1	0.07	633	4.9	0.5	242	5.3
OCT. '99	1.95	965	5.7	1.01	805	5.7				0.53	333	6.4	0.34			0.1			0.55	160	5.8	0.5	1008	5.1	-0.13	2410	5.8	-0.15	497	4.9				0.39	252	4.7
NOV. '99	2.09	1411	6.2	1.09	605	6				0.7	460	6.7	0.56	84	7.1	0.3	106	6.9	0.79	157	6.2	0.68	905	5.8	0.19	1186	5.2	0.11	608	6.2				0.72	463	
DEC. '99																																				
JAN. '00		2890	6.8		595	6.4					840	6.9								195	5.5		515	5.2		730	4.7		290	5.2					630	7.2
FEB. '00	0.53	3830	7	0.56	770	5.9				0.17	1960	8	0.38			0.26			0.1	195	5.6	-0.1	590	5.5	-0.12	775	4.9	-0.25	285	5.7				0.26		
MARCH '00	0.76	2350	6.6	0.54						0.25			0.38			0.42			0.2	150	5.5	0.19	210	5.6	0.23	635	4.2	-0.15	375	7.3						
APRIL '00	0.85	1385	6.5	0.51	560	5.8				0.21	725	7	0.35			0.42			0.14	170	5.6	0.04	195	5.2	0.28	560	4.7	-0.14	260	6.2				0.18		
MAY '00	1.12	1038	6.8	0.45	482	6				0.17	604	7	0.31			0.45			0.11	200	5.5	0.02	235	4.9	-0.24	538	4.4	-0.1	220	5.9				-0.24		
JUNE '00	0.93	739	6.8	0.47	454	5.9				0.22	809	7.1	0.31			-0.31	113	5.4	0.25	267	5.7	0.36	196	4.7	0.05	1670	4.2	0.08	334	5.6				-0.26		
JULY '00	1.15	950	6.7	0.43	460	5.8				0.24	745	7	0.31			-0.42			0.22	260	5.7	0.14	180	5.2	-0.09	1225	4.4	-0.01	480	5				0.8		
AUG. '00	1.08	955	6.8	0.38	615	6.9				0.15	760	7.1	0.3			-0.46			0.13	315	5.9	-0.03	200	4.6	-0.03	1030	4.6	0.02	625	5.6				-0.24		
SEP. '00	0.78	1266	6.9	0.29	572	7.2				0.25	786	7.1	0.33			-0.44			0.04	316	5.9	-0.09	218	4.5	-0.07	615	4.9	-0.08	801	5.3				-0.24		
OCT. '00	0.61			0.22	600	7.2				0.07	1865	7.8	0.36			0.56			-0.02	335	6	-0.15	280	6.1	0.01	810	5.7	-0.07	825	6.2				-0.24		
NOV. '00	0.93	1705	6.5	0.33	565	7.3				0.27	1505	7.2	0.34			-0.36			0.26	190	5.8	0.31	200	5.4	-0.03	1105	5.1	0.07	495	6.1						

DRAWINGS



0 250m

SCALE

LEGEND

- TEST PIT (CLEARY BROS) - LOCATION APPROXIMATE
- BORE (CLEARY BROS) - LOCATION APPROXIMATE
- BORE (DEPARTMENT OF MINERAL RESOURCES) - LOCATION APPROXIMATE
- CONE PENETRATION TEST (DOUGLAS PARTNERS)
- BORE (DOUGLAS PARTNERS)
- SURFACE CONTOUR (1m INTERVAL)
- APPROXIMATE OUTLINE OF PROPOSED SAND QUARRY APPLICATION

NOTE: FOR DETAILS OF SECTIONS A-A' & B-B' SEE DRAWING 2
FOR DETAILS OF SECTIONS C-C' TO G-G' SEE DRAWING 3

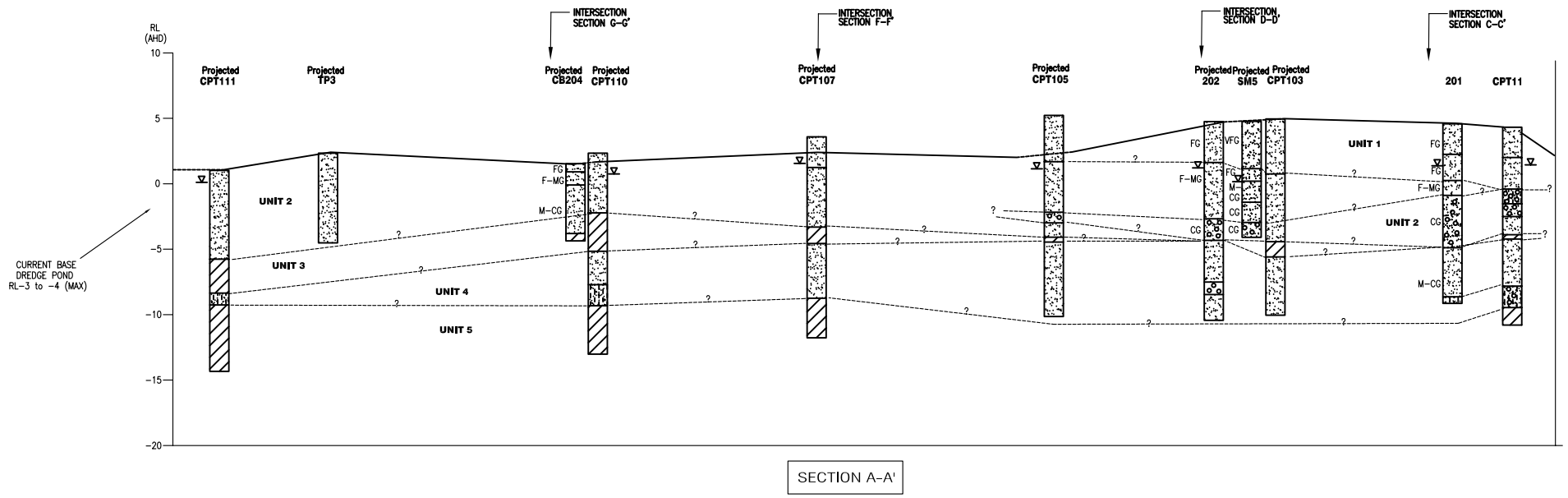
Douglas Partners
Geotechnics • Environment • Groundwater

Sydney, Newcastle, Brisbane
Melbourne,Perth, Wollongong
Campbelltown, Cairns, Darwin
Townsville

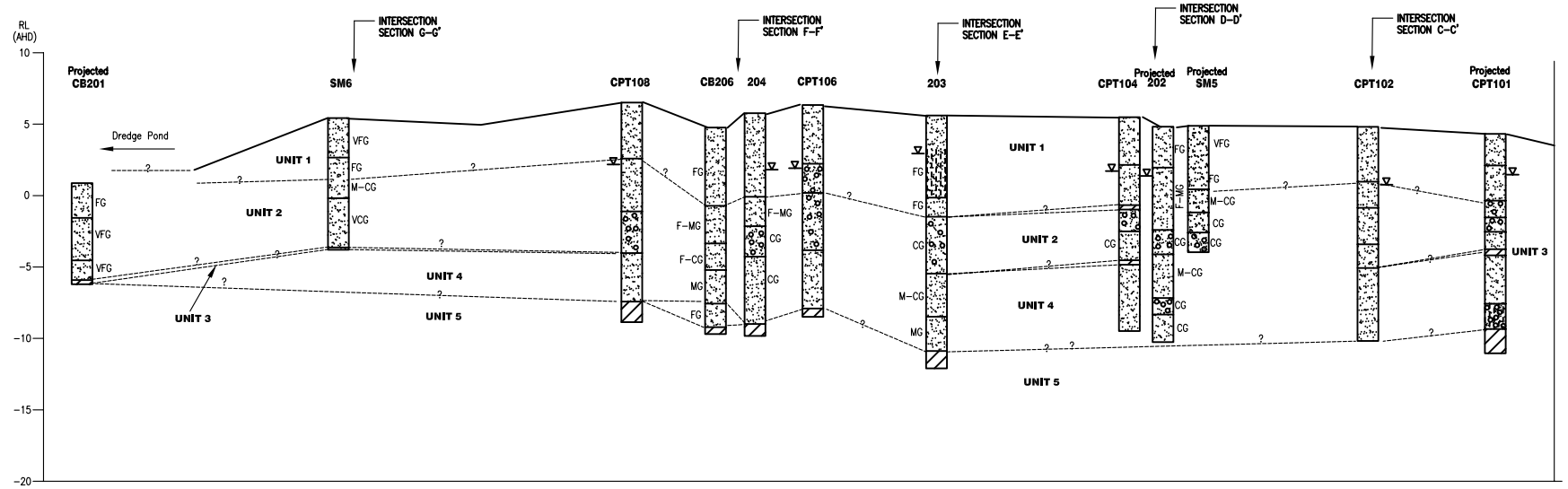
Title

LOCATION OF INVESTIGATION
PROPOSED NORTHERN EXTENSION
GERROA SAND QUARRY
GERROA

Client:	CLEARY BROS (BOMBO) PTY LTD				
Drawn By:	GRW	Scale:	1:4000	Project No.	37673
Approved By:	GRW			Office:	sydney
				Date	28/02/2005
				Drawing No.	1



SECTION A–A'



SECTION B–B'

LEGEND

- SAND
- SILTY SAND
- SANDY CLAY
- CLAY
- SANDY GRAVEL/GRAVELLY SAND
- SILTY SAND GRAVEL

VFG VERY FINE GRAINED
FG FINE GRAINED
MG MEDIUM GRAINED
CG COARSE GRAINED

WATER LEVEL
INTERPRETED BOUNDARY

NOTE: FOR LOCATIONS OF SECTIONS A–A' & B–B' SEE DRAWING 1

SCALE
0 5 10 15m
1:250 Vertical
10x Vertical Ex.

SCALE
0 50 100m
1:1250 Horizontal

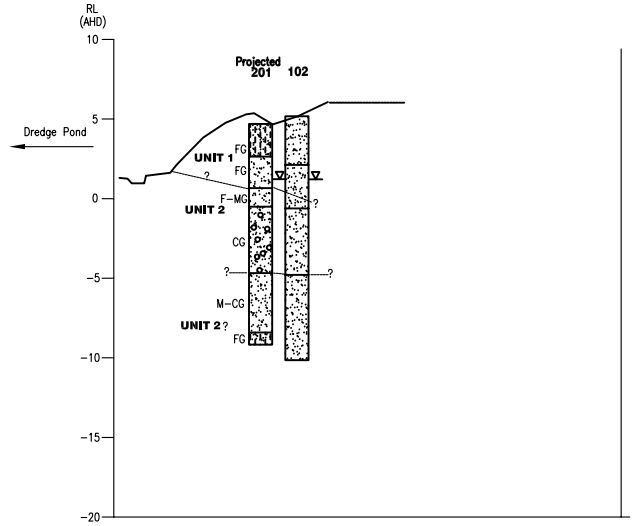
C:\DRAWINGS 2005\FEB 2005\3737\37673-2.dwg, 3/4/2005 10:10:26 AM

Douglas Partners
Geotechnics, Environment, Groundwater

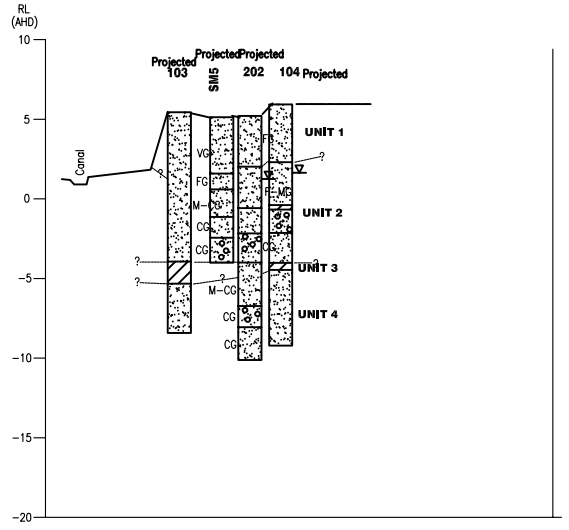
Sydney, Newcastle, Brisbane, Melbourne, Perth, Darwin, Wyong, Campbelltown, Townsville, Cairns, Wollongong

TITLE: Geological Sections A–A' & B–B'
Proposed Northern Extension
Gerroa Sand Quarry
GERROA

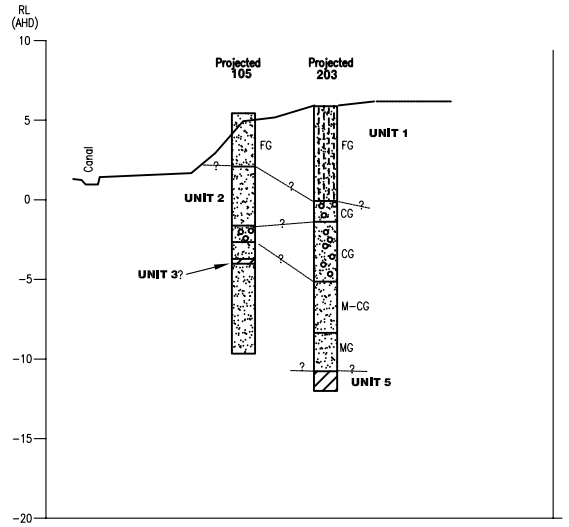
CLIENT: Cleary Bros (Bombo) Pty Ltd			
DRAWN BY: PSCH	SCALE: As shown	PROJECT No: 37673	OFFICE: SYDNEY
APPROVED BY:		DATE: 24.2.2005	DRAWING No: 2



SECTION C–C'



SECTION D–D'



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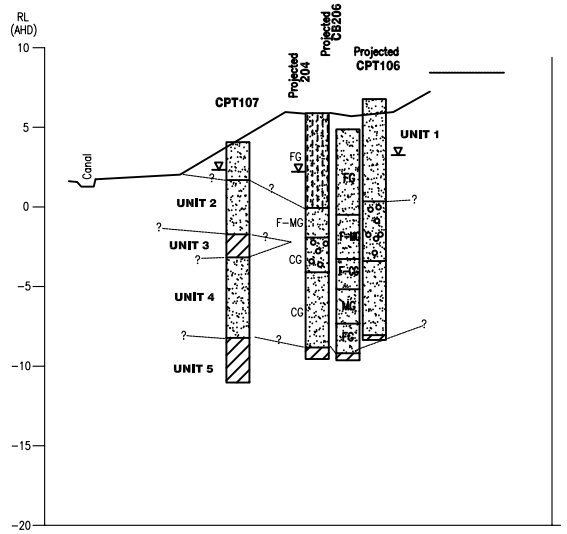
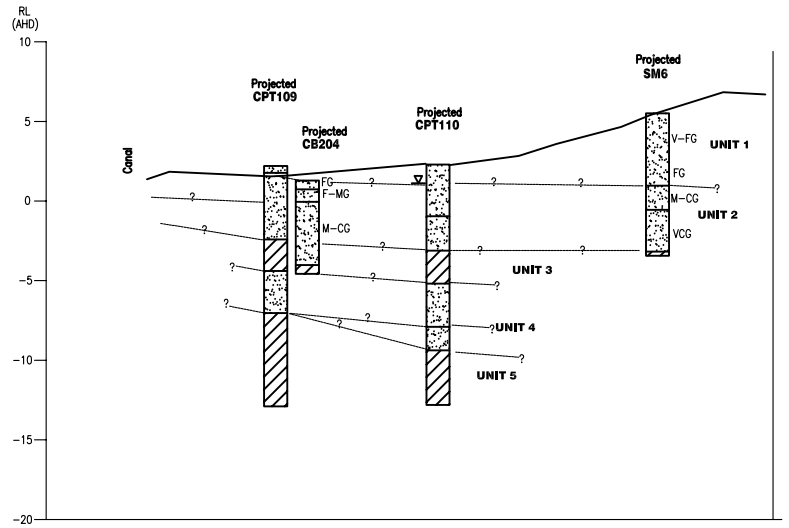


SECTION F–F'



SECTION G–G'

LEGEND

- SAND
- SILTY SAND
- SANDY CLAY
- CLAY
- SANDY GRAVEL/GRAVELLY SAND
- SILTY SAND GRAVEL

VFG VERY FINE GRAINED
FG FINE GRAINED
MG MEDIUM GRAINED
CG COARSE GRAINED

▽ WATER LEVEL
–?– – – – INTERPRETED BOUNDARY

SCALE
0 5 10 15m
1:250 Vertical
10x Vertical Ex.

SCALE
0 50 100m
1:1250 Horizontal

NOTE: FOR LOCATIONS OF SECTIONS C–C' TO G–G' SEE DRAWING 1

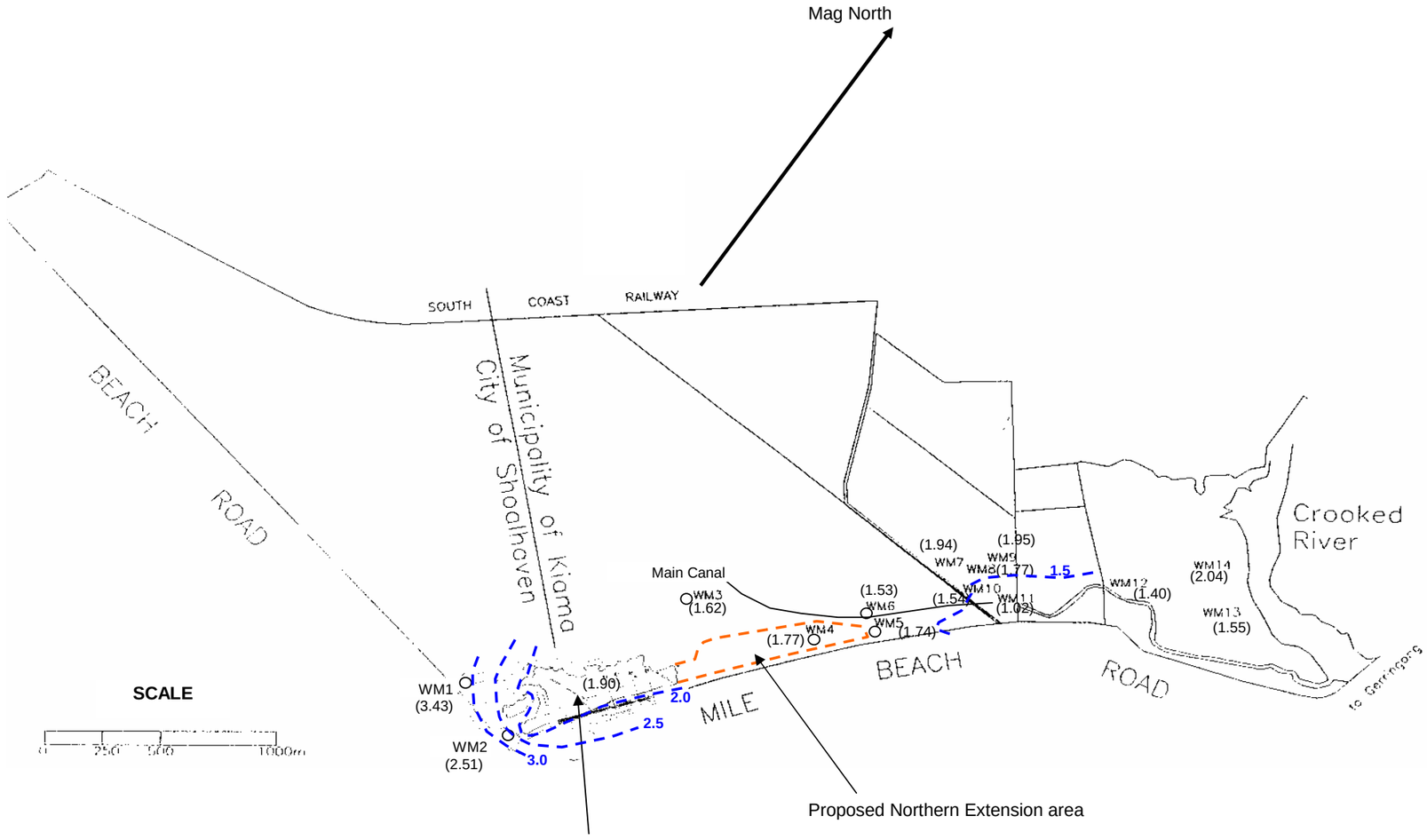
C:\DRAWINGS 2005\FEB 2005\3737\37673-3.dwg, 3/4/2005 10:08:00 AM

Douglas Partners
Geotechnics, Environment, Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Darwin, Wyong, Campbelltown, Townsville, Cairns, Wollongong

TITLE: Geological Sections C–C' TO G–G'
Proposed Northern Extension
Gerroa Sand Quarry
GERROA

CLIENT: Cleary Bros (Bombo) Pty Ltd			
DRAWN BY: PSCH	SCALE: As shown	PROJECT No: 37673	OFFICE: SYDNEY
APPROVED BY:		DATE: 24.2.2005	DRAWING No: 3

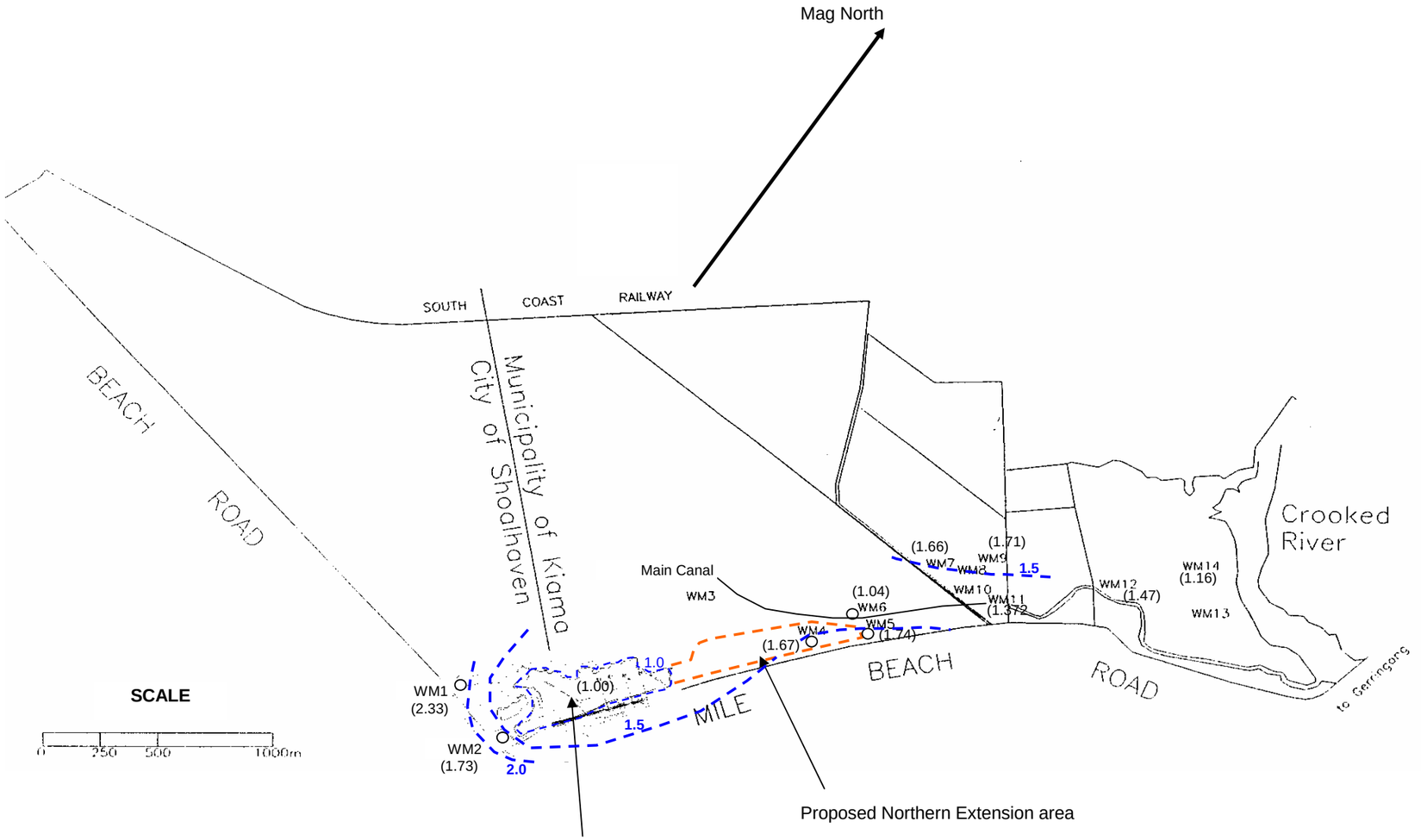


LEGEND

WM3 (1.62) Groundwater monitoring site (water level AHD)

Inferred groundwater contour

Client: Cleary Bros (Bombo) P/L		Project Number: 37673	**Douglas Partners** Geotechnics · Environment · Groundwater
		Date: 20.6.06	*Sydney, Newcastle, Brisbane, Wollongong*
Drawn by: GRW	Scale: As shown	Office: Sydney	*Melbourne, Perth, Wyong, Townsville, Cairns*
			Wollongong, Campbelltown, Darwin
Approved by:		Drawing No. 4	Title GROUNDWATER LEVELS - 29 JANUARY 1996 PROPOSED NORTHERN EXTENSION GERROA SAND QUARRY, GERROA



LEGEND

WM3 (1.62) Groundwater monitoring site (water level AHD)

Inferred groundwater contour

Client: Cleary Bros (Bombo) P/L		Project Number: 37673	Douglas Partners Geotechnics · Environment · Groundwater
		Date: 20.6.06	*Sydney, Newcastle, Brisbane, Wollongong*
Drawn by: GRW	Scale: As shown	Office: Sydney	*Melbourne, Perth, Wyong, Townsville, Cairns*
			Wollongong, Campbelltown, Darwin
Approved by:		Drawing No. 5	Title GROUNDWATER LEVELS - NOVEMBER 2000 PROPOSED NORTHERN EXTENSION GERROA SAND QUARRY, GERROA

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ADDENDUM TO REPORT on GEOTECHNICAL ASSESSMENT

PROPOSED NORTHERN EXTENSION OF GERROA SAND QUARRY GERROA AND BEACH ROADS, GERROA

Prepared for
CLEARY BROS (BOMBO) PTY LTD

Project 37673
September 2006

Douglas Partners
Geotechnics • Environment • Groundwater

ADDENDUM TO REPORT on GEOTECHNICAL ASSESSMENT

PROPOSED NORTHERN EXTENSION OF GERROA SAND QUARRY GERROA AND BEACH ROADS, GERROA

Prepared for
CLEARY BROS (BOMBO) PTY LTD

Project 37673
September 2006

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GRW:ss
Project 37673
28 September 2006

ADDENDUM TO REPORT ON GEOTECHNICAL ASSESSMENT
PROPOSED NORTHERN EXTENSION OF GERROA SAND QUARRY
GERROA AND BEACH ROADS, GERROA

1. INTRODUCTION

This addendum to the Douglas Partners Pty Ltd (DP) ***Report on Geotechnical Assessment, Proposed Northern Extension of Gerroa Sand Quarry, Gerroa and Beach Roads, Gerroa*** (Project 37673, dated 22 June 2006) presents comments in respect to:

- nutrient levels of the groundwater system in and adjacent to the existing dredge pond
- possible changes of the hydrogeological regime as a result of dredging in the proposed northern extension area.

It is understood that Cleary Bros (Bombo) Pty Ltd (CB) are seeking approval from the Minister for Planning to extract the sand resource, extending some 800 - 900 m northeast of the existing dredge pond area, over a period of about 15 years.

The following comments are based upon a review of the results of:

- groundwater and surface water chemical testing during 2005 and 2006 by Earth2Water Pty Ltd (E2W) and Enviro-Managers Pty Ltd (EM), the results being included in the annual environmental management reports for 2004 and 2005 and a recent analytical report dated 1 September 2006;
- periodic rainfall, extraction face location, dredge pond level and, groundwater monitoring bore data collected by CB;
- groundwater levels in site investigation bores.

Where relevant, information included in the June 2006 DP report is reproduced in the following sections to provide background to the current comments.

2. NUTRIENT LEVELS

As part of the environmental management plan for the operating sand quarry, CB carries out a water monitoring program including sampling and analysis of water samples from the dredge pond on weekly, monthly, six monthly and yearly intervals. The six monthly samples for the dredge pond are tested for a limited number of nutrients; ammonia, nitrate and total phosphorus. During the period January to November 2005, monitoring of groundwater chemistry within the drainage system of Foys Swamp and Blue Angle Creek also included assessment of nutrient levels.

A summary of the available test results for nutrients in the dredge pond during the period 2003 – 2006 is given in Table 1 which also includes ANZECC Guideline values for fresh water environments. The detailed results are included in Appendix A.

Table 1 – Summary of Nutrient Levels in Dredge Pond

Nutrient	Unit	ANZECC Guideline	Date										
			11/03	05/04	11/04	01/05	06/05	08/05	09/05	10/05	21/05	08/06	08/06
Ammonia as N	mg/L	0.9	<0.02	0.12	0.11	0.063	0.038	<0.01	0.20	0.03	0.19		
Nitrate as N	mg/L	0.7	0.02	<0.02	0.09	0.023	<0.01	0.025	<0.04	0.04	<0.04	0.04	0.04
Nitrite as N	mg/L					<0.01	<0.01	<0.01	0.034	0.022	0.027	0.06	0.05
Total Kjeldahl Nitrogen	mg/L					0.60	0.60	0.40	0.57	0.46	0.39	0.52	0.53
Total Phosphorus as P	mg/L	0.05	0.029	0.04	0.046	0.02	0.02	<0.01	0.014	0.026	<0.01	0.058	0.046
Reactive Phosphorus	mg/L						0.01	<0.01	<0.01	0.016	<0.01		

The testing results indicate that all samples included in Table 1 were within guideline values with the exception of one Total Phosphorus result from August 2006.

The testing of surface water from the Foy Swamp drainage system and its downstream continuation as Blue Angle Creek indicate that the nutrient levels have at various times exceeded the ANZECC Guideline values for Total Phosphorus. The test values for other nutrients were generally within guideline values.

The maximum values obtained from these sampling locations are compared in Table 2 with maximum values determined from dredge pond samples.

Table 2 – Summary of Maximum Nutrient Levels
Dredge Pond, Drainage System and Blue Angle Creek

Nutrient	Unit	ANZECC Guideline	Dredge Pond	Blue Angle Creek	Drainage System
Ammonia as N	mg/L	0.9	0.2	0.652	0.25
Nitrate as N	mg/L	0.7	0.09	0.231	0.09
Nitrite as N	mg/L		0.06	0.11	0.114
Total Kjeldahl Nitrogen	mg/L		0.6	2.3	2.4
Total Phosphorus as P	mg/L	0.05	0.058	0.28	1.02
Reactive Phosphorus	mg/L		0.016	0.912	<0.01

Review of the results in Table 1 indicates that water in the drainage system and Blue Angle Creek has generally higher concentrations of nutrients than the dredge pond.

3. HYDROGEOLOGY

3.1 Hydrogeological Setting

The Gerroa Sand Quarry and the proposed Northern Extension Area are located at the rear of the beach ridge system on low sand dune and sand sheet deposits.

During the DP 2004 investigation, groundwater was noted in the bores and inferred at hole collapse depths at CPT locations at RL 0.5 – 2.5 relative to Australian Height Datum (AHD). In comparison, maximum groundwater levels of approximately RL 0.9, RL 1.9 and RL 1.6 are

indicated by data obtained by Cleary Bros (Bombo) Pty Ltd in water monitoring bores WM 3, WM 4 and WM 5 (all lost at the time of the current investigation), respectively. At the time of the investigation, the dredge pond level was at approximately RL 1.1.

The distribution of measured or inferred groundwater levels during the site investigation is shown on Drawing 1 (see Appendix A). The interpreted distributions of groundwater during earlier monitoring (1996 and 2000) by CB in the Gerroa Sand Quarry and the area extending north-east to adjacent to the Crooked River are shown on Drawings 4 and 5 of the June 2006 DP report. These drawings are included in Appendix A for completeness.

The site investigation data and monitoring indicates:

- the alluvium acts as an aquifer in which there is a moderate variation in groundwater levels but a consistent, north-east trending flow gradient (about 0.3%) adjacent to the dredge pond, possibly reflecting the topographic bedrock high adjacent to southern side of Beach Road.
- elsewhere, there appears to be a generally easterly-trending flow gradient of about 0.1% - 0.2% towards the shore.
- there are locally even flatter gradients and reversals of gradient, suggesting that groundwater mounding within the dunes sheds both eastward to the sea and westward to the main drainage canal which continues northward as Blue Angle Creek and thence Crooked River (both of which are tidal).
- the zone of influence of the main canal (at approximately RL 1) appears to extend 80 m to 100 m eastward into the northern-most, 300 m long section of the proposed extension area, where groundwater levels are close to that of the canal.
- there is a relatively rapid change (about 0.8%) in groundwater levels between the area of highest dune (approximately central to the proposed extension area) and the areas to the north (towards the main canal) and to the southwest (towards the dredge pond).

3.2 Rainfall and Pond Level

The site is located immediately adjacent to the Shoalhaven Bight and within an area characterised by a median and mean annual rainfall of about 1165 mm and 1252 mm, respectively (on the basis of over 100 years records at the Kiama and Point Perpendicular monitoring stations). Detailed (daily) rainfall records for the period 1993 to 2000 from the Gerroa Sand Quarry indicate a median and mean annual rainfall of about 1047 mm and 1065 mm, respectively, some 10% to 15% below the anticipated long-term median and average values for the local coastal area and some 6% to 9% greater than the Nowra monitoring station about 13 km inland.

Measurements of the dredge pond level have been compared to available yearly rainfall for the site in the period 1993 – January 2006 and the anticipated median rainfall value (Table 3).

Table 3 – Summary of Yearly Rainfall and Dredge Pond Levels

	1993	1994	1995	1996	1997	1998	1999	2000	2005	2006
Maximum Level (AHD)	1.9	1.88	1.875	1.825	1.85	2.175	2.175	1.65	1.65	1.1
Minimum Level (AHD)	1.4	1.27	1.0	1.35	1.35	0.95	1.15	0.95	1.15	1.05
Range of Level (m)	0.5	0.53	0.875	0.475	0.5	1.225	1.025	0.7	0.5	0.05
Total Rainfall (mm)	755	926	1134	866	1101	1440	1309	993	1147	NA
Variation from Median Rainfall (mm)	-410	-239	-31	-299	-64	+275	+144	-172	-18	NA

NA = Not available

The results shown in Table 3 indicate that:

- 1998 and 1999 had rainfall in excess of the anticipated median (1165 mm) rainfall.
- the yearly maximum dredge pond level in years of less than median rainfall moved within a limited range (RL 1.65 – 1.9) with an average maximum of RL 1.83.

- the increase in dredge pond level in 1998 and 1999 corresponded closely with the rainfall in excess of the median value.
- the yearly minimum dredge pond level also moved within a limited range (RL 0.95 – 1.4).
- the minimum dredge pond level (RL 0.95), about the level of the main canal to the north of the site and adjacent to the proposed extension area.
- the maximum dredge pond level (RL 2.175) occurred during the year of highest rainfall (1998) indicating the rapid effect of rainfall on the groundwater regime.

The dredge pond levels have also been compared to daily rainfall events and the results of the 1999 - 2000 record periods (when the dredge pond area was slightly smaller than the current case). The comparison indicates that:

- for daily rainfall events generally in excess of 100 mm or close spaced rainfall events totalling about 100 mm there is a similar rise in the dredge pond level.
- high dredge pond levels declined rapidly towards the minimum (base) level between August 1999 (an above average rainfall period) and June 2000 (within a below average rainfall period) with the decline being stabilised in the February to May 2000 period by some seven rainfall events in the range 10 mm to 50 mm.

When dredge pond levels are compared to the levels in the groundwater monitoring bores, there is an indication that, during years of significantly lower than median rainfall (e.g. 1993), there is a possible localised reversal of groundwater flow at the eastern end of dredge pond (see Drawing 4) compared to a normal or slightly below median rainfall period (e.g. 2000) when flow gradient continues to the northeast (see Drawing 5).

3.3 Rainfall and Evaporation from Dredge Pond

The assessed median rainfall for the Gerroa area is about 1165 mm (in comparison with 1047 mm for the 1993 – 2000 period of recording at the Gerroa Sand Quarry). In comparison, available data for evaporation rates for a NSW south coast area recording station (Ulladulla) indicates that the average daily evaporation rate is of the order of 2.8 mm/day (1022 mm/year), less than either the assessed or measured rainfall data. It is however understood that readings

at the Nowra monitoring station indicate average evaporation of the order of 4 mm/day (about 1460 mm/year). The Ulladulla results are from a coastal location, similar to Gerroa, where temperatures and humidity would be affected by the proximity to the ocean. The Nowra results are from an inland location where temperatures and evaporation would be expected to be higher.

3.4 Effect of Proposed Dredging on Hydrology of the Site

Cleary Bros (Bombo) Pty Ltd are seeking approval from the Minister for Planning to extract the sand resource from the Northern Extension Area, which extends some 800 - 900 m northeast of the existing dredge pond area, over a period of about 15 years. The approximate outline of the area is given on Drawing 1.

It is expected that an excavation face ranging from 80 m to 160 m wide will be progressively moved northward from the current dredge pond and that excavation depths of up to 17 m will potentially be developed to recover sand product. The closest approach of the extraction area to the main canal will be 40 m and there will be a buffer, some 10 - 40 m wide, will be provided for screening bunds and EEC protection between the extraction area and road reserve (Gerroa Road).

It is understood that the Department of Environment and Conservation (DEC) requires information on whether the current and proposed dredging for sand will change the hydrology of the area, specifically in respect to the surrounding Endangered Ecological Communities (EEC). Two EECs are present within the quarry area:

- a Swamp Sclerophyll (Swamp mahogany) Forest on land generally lower than RL 2 on the western side of the dredge pond.
- a strip of Littoral Rainforest on the higher dunes adjacent to Gerroa Road and extending from the northern end of the existing dredge pond to where the bushland starts to thin to the north.

From consideration of the available data, site records and investigation, it is our opinion that:

- the groundwater levels will vary rapidly with rainfall and during periods of substantially above average rainfall could be expected to be similar to those prior to quarrying.
- the base groundwater level is controlled by the main canal system and will be unaltered by the proposed dredging. As a consequence of this (in conjunction with groundwater level rises during substantially above average rainfall), the proposed extraction within the Northern Extension Area sand resource is not expected to result in variation in the range of groundwater levels that have been previously experienced in the current dredge pond or adjacent water monitoring bores.
- the quarrying process could be expected to result in a minimal groundwater gradient between the dredge pond and the main drainage canal to the west (i.e. effectively the same as currently conditions).
- the quarrying process could be expected to result in a groundwater gradient of about 0.8% in the area immediately to the east of the dredge pond (i.e. effectively the same as current conditions) . For the base water level of the recorded pond level range, it is expected that the groundwater table will range from approximately RL 1 at the pond to approximately RL 1.4 at the eastern site boundary in the area of the littoral rainforest. It is expected that a similar differential will be present at the time of higher pond levels.
- the available chemical test results for surface and groundwater (see Appendix A) for the period 2003 to 2006 indicate that the water within the current dredge pond satisfied all ANZECC criteria with the exception of the Fe (total) value (which is expected to be naturally elevated in the geological environment including acid sulphate materials and weathering of pyritic iron which forms an accessory mineral of the underlying bedrock of the Berry Formation.
- the proposed extraction within the Northern Extension Area sand resource will not result in variation in the range pH or nutrient levels that have been previously experienced in the current dredge pond (or adjacent water monitoring bores).
- the final water body will not affect the overall commercial use of the aquifer. Average direct rainfall to the pond may be excess of the estimated yearly evaporation from the pond surface, the pH range (moderately acidic to strongly alkaline) is within the natural range of the groundwater and the down gradient landuse is restricted to National Park activities. It is

further understood that the quarrying to date has not resulted in observable changes to the stands of swamp mahogany, the closest of which are located within 5 m of the dredge pond.

- surface water release or groundwater movement from the proposed dredge pond is not expected to result in deterioration (or improvement) of the quality of the water in Blue Angle Creek.

DOUGLAS PARTNERS PTY LTD

Reviewed by

G R Wilson
Principal

Dr T J Wiesner
Principal

APPENDIX A
Notes Relating to this Report
Results of Chemical Testing
Drawings 1, 4 and 5.

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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water

table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7

  as 4, 6, 7
  N = 13

- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm

  as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

q_c (MPa) = (0.4 to 0.6) N (blows per 300 mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section

is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

ID	Parameter	Units	11/19/2003	05/27/2004	11/26/2004
South Reed Bed	Ammonia	mg/l	<0.02	0.29	<0.02
	Chloride	mg/l	66	65	94
	Conductivity	uS/cm@25C	-	620	-
	Nitrate	mg/l	<0.02	<0.02	0.08
	Oil & Grease	mg/l	<0.1	<0.1	0.2
	pH	pH units	8	7.3	6.5
	Sulphate	mg/l	73	82	8
	Total Phosphorus	mg/l	0.057	0.07	0.068
Existing Works Area	Ammonia	mg/l	<0.02	0.12	0.11
	Chloride	mg/l	64	68	66
	Conductivity	uS/cm@25C	557	620	530
	Nitrate	mg/l	0.02	<0.02	0.09
	Oil & Grease	mg/l	<0.1	3.2	<0.1
	pH	pH units	8.2	7.3	6.8
	Sulphate	mg/l	70	86	88
	Total Phosphorus	mg/l	0.029	0.04	0.046

Analytical Report - Enviro-Managers	
Client:	**Cleary Bros (Bombo) Pty Ltd**
	Springhill Rd
	CONISTON **NSW, 2500**
Phone:	**0408 226 190**
Fax:	**02 4276 1168**
Contact Name:	**Mr Ron Bryant**
Client Reference:	**Gerroa**

	Report Number:	**W05/2090**	**W05/2090**	**W05/4409**	**W05/4409**
Results:	**Sample Received:**	**26/05/2005**	**26/05/2005**	**21/11/2005**	**21/11/2005**
Client Id		**Ex Works**	**Sth Reed**	**Ex Works**	**Sth Reed**
Laboratory Id		**W12803/001**	**W12803/002**	**W15172/001**	**W15172/002**
Ammonia (NH3 as N)					
Method:WCM084	*Units:mg/L*	0.04	0.03	0.61	0.38
Chloride					
Method:WCM055	*Units:mg/L*	72	56	80	59
Nitrate (NO3 as N)					
Method:WCM085	*Units:mg/L*	0.06	0.03	<0.04	0.09
Oil & grease					
Method:APHA 5520	*Units:mg/L*	<0.1	<0.1	<0.1	<0.1
pH					
Method:APHA 4500 H B	*Units:pH units*	6.8	6.5	7.7	6.8
Sulphate (SO4)					
Method:APHA 3120 B	*Units:mg/L*	123	8.6	138	16
Total Phosphorus (TP)					
Method:WCM090	*Units:mg/L*	<0.002	<0.002	<0.005	<0.005
Method(s):					
APHA 3120 B	Sulphate (SO4)				
APHA 4500 H B	pH				
APHA 5520	Oil & grease				
WCM055	Chloride				
WCM084	Ammonia (NH3 as N)				
WCM085	Nitrate (NO3 as N)				
WCM090	Total Phosphorus (TP)				

Table 1A- Gerroa 6 Monthly Surface Water Results (Ex Works, Sth Reed)

	Report Number:		W05/2090	W05/4409		W05/2090	W05/4409	
Results:	Sample Received:	Guidelines	26/05/2005	21/11/2005	Average	26/05/2005	21/11/2005	Average
Client Id		ANZECC (2000) Freshwater	Ex Works	Ex Works		Sth Reed	Sth Reed	
Laboratory Id			W12803/001	W15172/001		W12803/002	W15172/002	
Ammonia (NH3 as N)								
Method:WCM084	*Units:mg/L*	0.9	0.04	0.61	0.325	0.03	0.38	0.205
Chloride								
Method:WCM055	*Units:mg/L*	250	72	80	76	56	59	57.5
Nitrate (NO3 as N)								
Method:WCM085	*Units:mg/L*	0.7	0.06	<0.04		0.03	0.09	0.06
Oil & grease								
Method:APHA 5520	*Units:mg/L*	No Visible Sheen	<0.1	<0.1		<0.1	<0.1	
pH								
Method:APHA 4500 H B	*Units:pH units*	6 - 9.0	6.8	7.7	7.25	6.5	6.8	6.65
Sulphate (SO4)								
Method:APHA 3120 B	*Units:mg/L*	250	123	138	130.5	8.6	16	12.3
Total Phosphorus (TP)								
Method:WCM090	*Units:mg/L*	NA	<0.002	<0.005		<0.002	<0.005	

TABLE 1: Surface Water Analytical Results

Foys Swamp, Blue Angle Creek and Gerroa Sand Quarry

Cleary Bros (Bombo) Pty Ltd	*Water Monitoring Program*			Sample ID	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-1	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	M.DRAIN-2	BA Creek	BA Creek	BA Creek
				Sample ID	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-up stream	Main Drain-dn stream	Main Drain-dn stream	Main Drain-dn stream	Main Drain- dn stream	Main Drain- dn stream	Main Drain- dn stream	Main Drain- dn stream	Blue Angle Creek	Blue Angle Creek	Blue Angle Creek
	Units	LOR	ANZECC 2000 Guidelines		Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather
Metals (total)			Marine	Fresh	27/01/05	28/04/05	2/06/05	3/08/05	21/09/05	21/10/06	21/11/05	27/01/05	28/04/05	2/06/05	3/08/05	21/09/05	21/10/06	21/11/05	3/02/05	28/04/05	2/06/05
Aluminium (PH>6.5,)	mg/L	0.0001	ID	0.055			**0.99**	**2.7**			**0.26**			**0.56**	**0.4**			**0.12**			**0.59**
Arsenic	mg/L	0.001	ID	0.013	<0.001		<0.001	<0.001			<0.001	0.002		<0.001	<0.001			<0.001	0.002		0.004
Beryllium	mg/L	0.001	ID	ID	<0.001							<0.001							0.001		
Barium	mg/L	0.001	ID	ID	0.016							0.015							0.014		
Cadmium	mg/L	0.0001	0.0007	0.0002	0.0002		<0.0001	<0.0001			<0.001	**0.0003**		<0.0001	<0.0001			<0.001	**0.0004**		<0.0001
Chromium (Total)	mg/L	0.001	0.0274	ID	0.003		<0.001	0.001				0.003		<0.001	<0.001				0.003		<0.001
Cobalt	mg/L	0.001	0.001	ID	0.01							0.009							**0.004**		
Copper	mg/L	0.001	0.0013	0.0014	<0.001		**0.003**	**0.006**			<0.001	<0.001		**0.003**	**0.002**			<0.001	**0.01**		**0.006**
Lead	mg/L	0.001	0.0044	0.0034	<0.001		<0.001	<0.001			<0.001	<0.001		<0.001	<0.001			<0.001	0.01		<0.001
Zinc	mg/L	0.005	0.015	0.008	**0.013**		**0.012**	**0.031**			<0.005	**0.012**		**0.023**	**0.009**			<0.005	**0.023**		**0.022**
Manganese	mg/L	0.001	ID	1.9	0.596							0.543							0.14		
Nickel	mg/L	0.001	0.007	0.011	0.01							0.009							0.006		
Vanadium	mg/L	0.01	0.1	ID	<0.01							<0.01							<0.01		
Total Iron	mg/L	0.005	ID	ID	0.75		0.71	2.48			0.30	0.42		0.49	0.52			0.11	<0.1		2.07
Mercury	mg/L	0.0001	0.0001	0.00006	<0.0001		<0.0001	<0.0001			<0.0005	<0.0001		<0.0001	<0.0001			<0.0005	0.0001		<0.0001
Weak Acid Dissociable Cyanide	mg/L	0.005	0.004	0.007	- - -							<0.0050							- - -		
Nutrients																					
Fluoride	mg/L	0.1			- - -							- - -							0.1	- - -	
Ammonia as N	mg/L	0.01	0.91	0.9	0.052	0.028	0.073	0.084	0.18	<0.02	0.25	0.096	0.031	0.047	0.02	0.17	0.02	0.19	0.048	0.282	0.53
Nitrate as N	mg/L	0.01	ID	0.7	<0.010	<0.010	0.026	0.014	<0.04	0.05	<0.04	<0.010	<0.010	<0.010	0.023	<0.04	0.09	<0.04	<0.010	0.062	<0.010
Nitrite as N	mg/L	0.01			<0.010		<0.010	0.013	<0.002	0.014	0.004	<0.010	<0.010	<0.010	<0.010	<0.002	0.014	0.005	0.014	<0.010	0.026
Total Kjeldahl Nitrogen as N	mg/L	0.10			0.80	0.60	2.40	2.20	0.84	0.53	0.63	0.70	0.50	0.90	0.60	0.86	0.48	0.47	1.80	1.00	2.30
Total Phosphorus as P	mg/L	0.01		0.05	0.04	0.01	**0.25**	**1.02**	<0.005	<0.005	<0.005	0.01	<0.010	0.02	<0.01	<0.005	<0.005	<0.005	**0.18**	**0.06**	**0.28**
Reactive Phosphorus	mg/L	0.01			<0.010	<0.01	<0.010	<0.010	<0.004	<0.004	<0.004	0.912	<0.010	<0.010	<0.010	<0.004	<0.004	<0.004	- - -	<0.010	<0.010
PH (lab)	pH Unit	0.01			- - -	6.17	6.72	6.33	7.20	7.00	6.80	- - -	6.90	6.71	6.68	7.00	7.00	6.90	- - -	6.80	6.87
Total Dissolved Solids (TDS)	mg/L	1			552	2460	646	1230	***4515.8***	***5808.9***	***3577.8***	- - -	1240	644	1730	***3912.8***	***5453.8***	***4127.2***	303	2330	18500
Electrical Conductivity	uS/cm	1							6740	8670	5340					5840	8140	6160			
Suspended Solids (SS)	mg/L	1			11	7		3				6	10		9				23	13	
Total Hardness	mg/L	1			164	- - -						- - -							73		
Major Ions																					
Calcium	mg/L	1			28		37				53	- - -						63	13		225
Magnesium	mg/L	1			20		26				93	- - -						110	10		587
Sodium	mg/L	1			87		134				669	- - -						789	39		4460
Potassium	mg/L	1			10		10				31	- - -						36	6		176
Bicarbonate as CaCO3	mg/L	1			2		31					- - -							10		90
Total Alkalinity	mg/L	1			2		31					- - -							10		90
Sulphate as SO4	mg/L	1			159		182				293	- - -						392	63		1200
Chloride	mg/L	1			130		212				1308	- - -						1684	64.5		8930
SAR																					
Calcium + Magnesium (meq/L)					3.04		3.99				10.29	- - -						12.19	1.47		59.51
Sodium (meq/L)					3.78		5.83				29.10	- - -						34.32	1.70		194.01
SAR= Na / Sqrt (Ca+ Mg) / 2)					1.23		1.41				2.27	- - -						2.47	0.86		5.46
SAR- Sodium Absorption Ratio					**3.07**		**4.13**				**12.83**	**- - -**						**13.90**	**1.98**		**35.57**
SAR Hazard Ranking					**Low**		**Low**				**Med**							**Med**	**Low**		**V High**

Note:

SAR Hazard ranking based on Fetter, 1994.

Low = 2 to 10, Med = 7 to 18, High= 11 to 26, V High= 26+

nr - no recommended NSW guidelines NA - Not Available

TDS= EC*0.67 (approximate) calculation in italics (Data from Sept to Dec05)

3 3 Exceeds ANZECC 2000 trigger values (marine and/or fresh water)

TABLE 1: Surface Water Analytical Results

Foys Swamp, Blue Angle Creek and Gerroa Sand Quarry

Cleary Bros (Bombo) Pty Ltd	***Water Monitoring Program***			Sample ID	BA Creek	BA Creek	BA Creek	BA Creek	SW Drain	SW Drain	SW Drain
				Sample ID	Blue Angle Creek	Blue Angle Creek	Blue Angle Creek	Blue Angle Creek	SW Drain	SW Drain	SW Drain
	Units	LOR	ANZECC 2000 Guidelines		Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather
Metals (total)			Marine	Fresh	3/08/05	21/09/05	21/10/06	21/11/05	27/01/05	2/06/05	21/11/2005
Aluminium (PH>6.5,)	mg/L	0.0001	ID	0.055	**1.47**			**0.02**			
Arsenic	mg/L	0.001	ID	0.013	0.003			<0.001	0.004		
Beryllium	mg/L	0.001	ID	ID					<0.001		
Barium	mg/L	0.001	ID	ID					0.019		
Cadmium	mg/L	0.0001	0.0007	0.0002	<0.0001			<0.001	<0.0001		
Chromium (Total)	mg/L	0.001	0.0274	ID	0.001				0.003		
Cobalt	mg/L	0.001	0.001	ID					**0.002**		
Copper	mg/L	0.001	0.0013	0.0014	**0.008**			<0.001	**0.002**		
Lead	mg/L	0.001	0.0044	0.0034	<0.001			<0.001	<0.001		
Zinc	mg/L	0.005	0.015	0.008	**0.016**			<0.005	**0.412**		
Manganese	mg/L	0.001	ID	1.9					0.003		
Nickel	mg/L	0.001	0.007	0.011					<0.01		
Vanadium	mg/L	0.01	0.1	ID					<0.005		
Total Iron	mg/L	0.005	ID	ID	7.12			0.28	2.16		
Mercury	mg/L	0.0001	0.0001	0.00006	<0.0001			<0.0005	<0.0001		
Weak Acid Dissociable Cyanide	mg/L	0.005	0.004	0.007					- - -		
Nutrients											
Fluoride	mg/L	0.1							- - -		
Ammonia as N	mg/L	0.01	0.91	0.9	0.652	0.22	0.12	0.26	0.074	0.096	0.15
Nitrate as N	mg/L	0.01	ID	0.7	0.231	0.05	0.08	<0.04	<0.010	0.016	<0.04
Nitrite as N	mg/L	0.01			0.114	0.005	0.021	0.004	0.012	<0.010	0.11
Total Kjeldahl Nitrogen as N	mg/L	0.10			0.90	0.73	0.58	0.44	- - -	1.50	1.5
Total Phosphorus as P	mg/L	0.01		0.05	0.05	<0.005	<0.005	<0.005	**0.31**	**0.13**	0.05
Reactive Phosphorus	mg/L	0.01			<0.010	<0.004	<0.004	<0.004	- - -	0.123	0.043
PH (lab)	pH Unit	0.01			6.89	7.00	6.90	6.70	- - -	6.87	7.5
Total Dissolved Solids (TDS)	mg/L	1			3620	***3752***	***7624.6***	***4107.1***	203	243	520
Electrical Conductivity	uS/cm	1				5600	11380	6130			
Suspended Solids (SS)	mg/L	1			26				20		
Total Hardness	mg/L	1							52		
Major Ions											
Calcium	mg/L	1						63	10		
Magnesium	mg/L	1						111	7		
Sodium	mg/L	1						808	26		
Potassium	mg/L	1						37	7		
Bicarbonate as CaCO3	mg/L	1							39		
Total Alkalinity	mg/L	1							39		
Sulphate as SO4	mg/L	1						345	8		
Chloride	mg/L	1						1635	49		
SAR											
Calcium + Magnesium (meq/L)								12.27	1.07		
Sodium (meq/L)								35.15	1.13		
SAR= Na / Sqrt (Ca+ Mg) / 2)								2.48	0.73		
SAR- Sodium Absorption Ratio								**14.19**	**1.54**		
SAR Hazard Ranking								**Med**	**Low**		

Note:
SAR Hazard ranking based on Fetter, 1994.
Low = 2 to 10, Med = 7 to 18, High= 11 to 26, V High= 26+
nr - no recommended NSW guidelines NA - Not Available
TDS= EC*0.67 (approximate) calculation in italics (Data from Sept to Dec05)

TABLE 1: Surface Water Analytical Results

Foys Swamp, Blue Angle Creek and Gerroa Sand Quarry

Cleary Bros (Bombo) Pty Ltd	***Water Monitoring Program***			Sample ID	W Drain	W Drain	W Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	Dredge Pond	Dredge Pond	Dredge Pond	Dredge Pond	Dredge Pond	Dredge Pond
				Sample ID	W Drain	W Drain	W Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	NW Drain	MD Pond	MD Pond	MD Pond	MD Pond	MD Pond	MD Pond
	Units	LOR	ANZECC 2000 Guidelines		Wet Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Wet Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather	Dry Weather
Metals (total)			Marine	Fresh	27/01/2005	2/06/2005	21/11/2005	27/01/2005	2/06/05	3/08/05	21/09/05	21/10/05	21/11/05	27/01/05	2/06/05	3/08/05	21/09/05	21/10/05	21/11/05
Aluminium (PH>6.5,)	mg/L	0.0001	ID	0.055					**3.04**	**2.83**			**18**		**1.42**	**1.28**			**1.9**
Arsenic	mg/L	0.001	ID	0.013	0.003			<0.001	<0.001	<0.001			<0.001	0.004	0.003	0.002			<0.001
Beryllium	mg/L	0.001	ID	ID	<0.001			0.002						<0.001					
Barium	mg/L	0.001	ID	ID	0.03			0.028						0.01					
Cadmium	mg/L	0.0001	0.0007	0.0002	**0.0005**			**0.0003**	<0.0001	<0.0001			<0.001	0.0002	<0.0001	<0.0001			<0.001
Chromium (Total)	mg/L	0.001	0.0274	ID	0.003			0.002	<0.001	<0.001				0.004	0.002	0.001			
Cobalt	mg/L	0.001	0.001	ID	<0.001			**0.038**						<0.001					
Copper	mg/L	0.001	0.0013	0.0014	**0.025**			**0.003**	**0.002**	**0.004**			**0.002**	<0.001	**0.002**	**0.003**			<0.001
Lead	mg/L	0.001	0.0044	0.0034	0.001			<0.001	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001			<0.001
Zinc	mg/L	0.005	0.015	0.008	**0.072**			**1.72**	**0.035**	**0.019**			**0.053**	0.015	**0.05**	**0.012**			<0.005
Manganese	mg/L	0.001	ID	1.9	0.004			0.028						0.003					
Nickel	mg/L	0.001	0.007	0.011	<0.01			<0.01						<0.01					
Vanadium	mg/L	0.01	0.1	ID	**0.022**			0.045						<0.005					
Total Iron	mg/L	0.005	ID	ID	0.83			8.64	0.39	1.4			0.58	0.77	1.14	0.78			0.57
Mercury	mg/L	0.0001	0.0001	0.00006	<0.0001			**0.0016**	<0.0001	<0.0001			<0.0005	<0.0001	<0.0001	<0.0001			<0.0005
Weak Acid Dissociable Cyanide	mg/L	0.005	0.004	0.007	- - -			- - -						<0.0050					
Nutrients																			
Fluoride	mg/L	0.1			- - -			- - -						0.2					
Ammonia as N	mg/L	0.01	0.91	0.9	0.055	0.043	0.35	0.066	0.046	0.059	0.23	<0.02	0.31	0.063	0.038	<0.010	0.20	0.03	0.19
Nitrate as N	mg/L	0.01	ID	0.7	0.011	<0.010	<0.04	<0.010	0.301	<0.010	<0.04	<0.04	<0.04	0.023	<0.010	0.025	<0.04	0.04	<0.04
Nitrite as N	mg/L	0.01			<0.010	<0.010	0.022	<0.010	<0.010	<0.010	<0.002	0.014	<0.002	<0.010	<0.010	<0.010	0.034	0.022	0.027
Total Kjeldahl Nitrogen as N	mg/L	0.10			- - -	1.00	5.7	- - -	1.20	2.10	0.62	0.50	0.46	0.60	0.60	0.40	0.57	0.46	0.39
Total Phosphorus as P	mg/L	0.01		0.05	**0.18**	**0.12**	**0.4**	**0.08**	0.03	**0.35**	0.006	<0.005	<0.005	0.02	0.02	<0.01	0.014	0.026	<0.005
Reactive Phosphorus	mg/L	0.01			- - -	0.066	<0.004	- - -	<0.010	<0.010	<0.004	<0.004	<0.004	- - -	0.01	<0.010	<0.004	0.016	<0.004
PH (lab)	pH Unit	0.01			- - -	7.43	8.20	- - -	4.43	5.06	6.40	6.40	3.80	- - -	7.06	7.47	7.60	7.40	7.50
Total Dissolved Solids (TDS)	mg/L	1			306	220	720	914	406	410	***1742***	***2639.8***	***1815.7***	360	324	336	***406.69***	***425.45***	***589.6***
Electrical Conductivity	uS/cm	1									2600	3940	2710				607	635	880
Suspended Solids (SS)	mg/L	1			21			31		50				11		7			
Total Hardness	mg/L	1			103			212						- - -					
Major Ions																			
Calcium	mg/L	1			24			32	18				60	43	42				47
Magnesium	mg/L	1			10			32	17				65	12	11				14
Sodium	mg/L	1			41			123	78				257	46	42				51
Potassium	mg/L	1			7			10	4				12	4	4				5.2
Bicarbonate as CaCO3	mg/L	1			75			<1	<1					48	47				
Total Alkalinity	mg/L	1			75			<1	<1					48	47				
Sulphate as SO4	mg/L	1			32			264	140				533	109	104				134
Chloride	mg/L	1			61.1			166	110				445	65.5	71				82
SAR																			
Calcium + Magnesium (meq/L)					2.02			4.23	2.30				8.34	3.13	3.00				3.50
Sodium (meq/L)					1.78			5.35	3.39				11.18	2.00	1.83				2.22
SAR= Na / Sqrt (Ca+ Mg) / 2)					1.01			1.45	1.07				2.04	1.25	1.22				1.32
SAR- Sodium Absorption Ratio					**1.77**			**3.68**	**3.17**				**5.47**	**1.60**	**1.49**				**1.68**
SAR Hazard Ranking					**Low**			**Low**	**Low**				**Low**	**Low**	**Low**				**Low**

Note:
SAR Hazard ranking based on Fetter, 1994.
Low = 2 to 10, Med = 7 to 18, High= 11 to 26, V High= 26+
nr - no recommended NSW guidelines NA - Not Available
TDS= EC*0.67 (approximate) calculation in italics (Data from Sept to Dec05)

Ecowise Environment

Analytical Report

Cleary Bros (Bombo) Pty Ltd
39 Five Islands Road
PORT KEMBLA
NSW, 2505

Phone: **0408 226 190**
Fax: **02 95430688**

Contact Name:	**Alan Kerr**
Report Number:	**W06/3224**
Sample(s) Received:	**25/08/2006**
Client Reference:	**Gerroa Sands**
Batch Number:	**W18849**

Notes:

The results stated in this report relate only to the sample(s) as submitted by the client.
Samples analysed as received.

Results Approved By:

Abdul Khan
Lab Supervisor

NATA Accredited Laboratory
Number. 3626 (Chemical Testing)
Number. 3629 (Biological Testing)

NATA
WORLD RECOGNISED
ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Date Reported: Friday September 1, 2006

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Ecowise Environment

Analytical Report — Report No: W06/3224

Results:

Client Id		Gerroa East	West			
Laboratory Id		W18849/001	W18849/002			
Nitrate (NO3 as N)						
Method: WCM085	*Units: mg/L*	0.04	0.04			
NOx (as N)						
Method: WCM085	*Units: mg/L*	0.06	0.05			
Phosphate as P						
Method: WCM089	*Units: mg/L*	<0.004	<0.004			
Total Nitrogen (TN)						
Method: WCM083	*Units: mg/L*	0.52	0.53			
Total Phosphorus (TP)						
Method: WCM090	*Units: mg/L*	0.056	0.046			

Methods:

WCM083	Total Nitrogen (TN)
WCM085	Nitrate (NO3 as N)
WCM085	NOx (as N)
WCM089	Phosphate as P
WCM090	Total Phosphorus (TP)

Date Reported: Friday September 1, 2006

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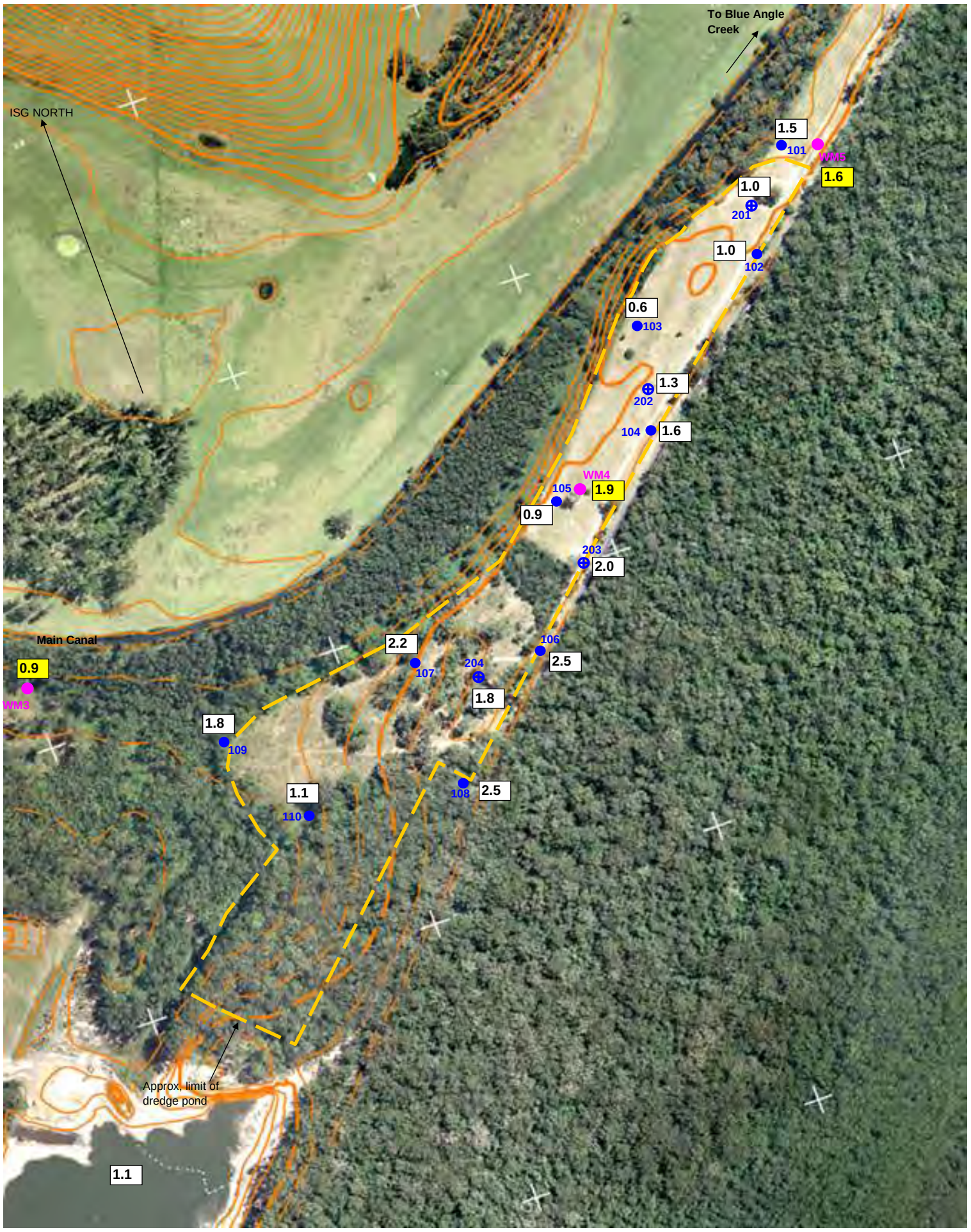


LEGEND

- CONE PENETRATION TEST (DOUGLAS PARTNERS)
- BORE (DOUGLAS PARTNERS)
- SURFACE CONTOUR (1m INTERVAL)
- APPROXIMATE OUTLINE OF PROPOSED SAND QUARRY APPLICATION
- GROUNDWATER MONITORING BORE (APPROX. LOCATION ONLY)
- 1.5 GROUNDWATER LEVEL (AHD) EITHER ESTIMATED FROM FALL IN DEPTH IN CPTS OR DIRECT MEASUREMENT OF GROUNDWATER IN BORES
- 1.5 MAXIMUM GROUNDWATER LEVEL FROM MONITORING

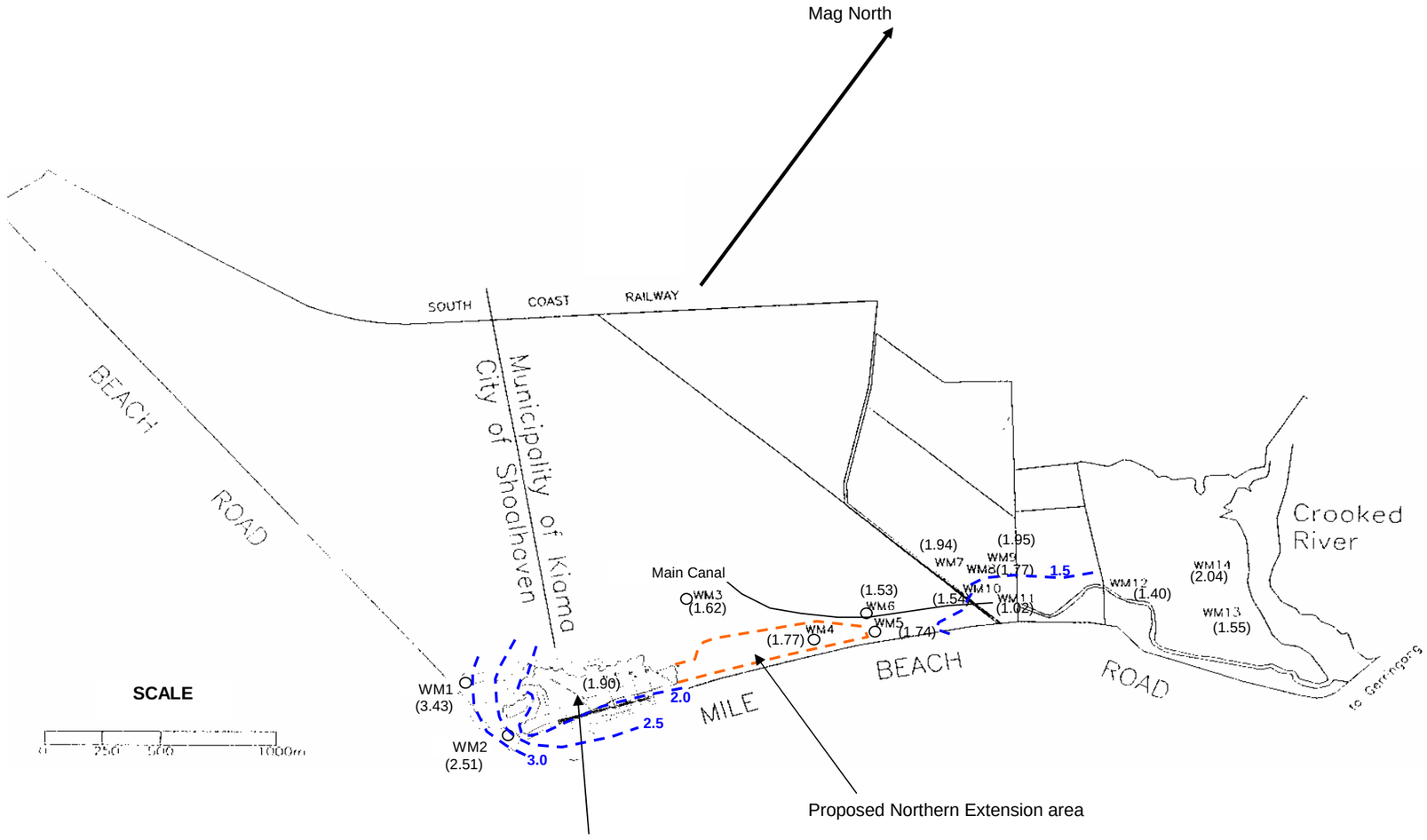
Douglas Partners
Geotechnics · Environment · Groundwater

Sydney, Newcastle, Brisbane Melbourne,Perth, Wollongong Campbelltown, Cairns, Darwin Townsville

Title

GROUNDWATER LEVELS DECEMBER 2004
PROPOSED NORTHERN EXTENSION
GERROA SAND QUARRY
GERROA

Client:	CLEARY BROS (BOMBO) PTY LTD				
Drawn By:	GRW	Scale:	As shown	Project No.	37673B
Approved By:	GRW			Date	5/09/2006
Office:	Sydney				
Drawing No.	1 Addendum				

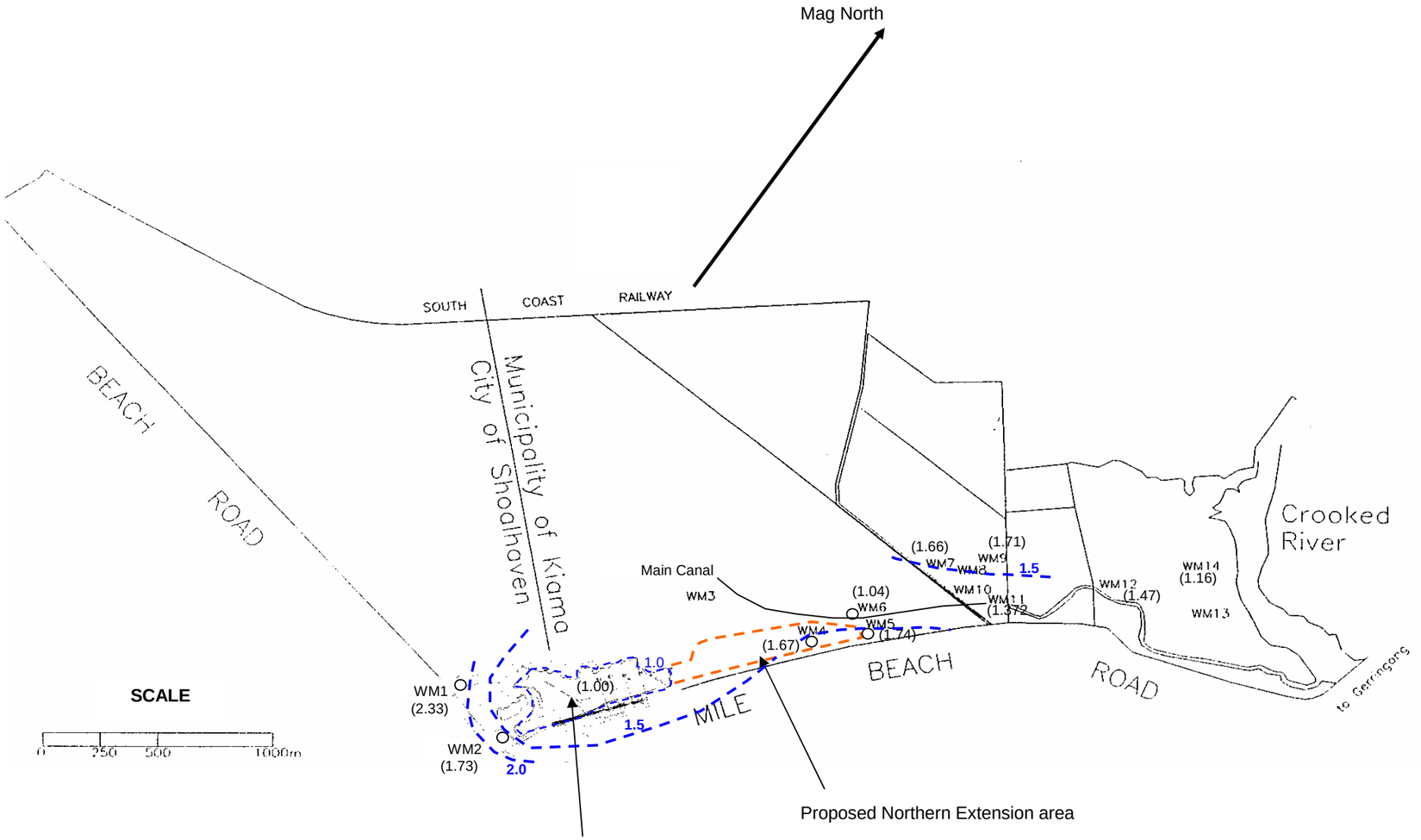


LEGEND

WM3 (1.62) Groundwater monitoring site (water level AHD)

Inferred groundwater contour

Client: Cleary Bros (Bombo) P/L		Project Number: 37673	**Douglas Partners** Geotechnics · Environment · Groundwater
		Date: 20.6.06	*Sydney, Newcastle, Brisbane, Wollongong*
Drawn by: GRW	Scale: As shown	Office: Sydney	*Melbourne, Perth, Wyong, Townsville, Cairns*
			Wollongong, Campbelltown, Darwin
Approved by:		Drawing No. 4	Title GROUNDWATER LEVELS - 29 JANUARY 1996 PROPOSED NORTHERN EXTENSION GERROA SAND QUARRY, GERROA



LEGEND

WM3 (1.62) Groundwater monitoring site (water level AHD)

Inferred groundwater contour

Client: Cleary Bros (Bombo) P/L		Project Number: 37673	Douglas Partners Geotechnics · Environment · Groundwater
		Date: 20.6.06	*Sydney, Newcastle, Brisbane, Wollongong*
Drawn by: GRW	Scale: As shown	Office: Sydney	*Melbourne, Perth, Wyong, Townsville, Cairns*
			Wollongong, Campbelltown, Darwin
Approved by:		Drawing No. 5	Title GROUNDWATER LEVELS - NOVEMBER 2000 PROPOSED NORTHERN EXTENSION GERROA SAND QUARRY, GERROA